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ABSTRACT

This document consists of both the "Teacher Edition" and the matching "Student Edition" for a course to help high school students develop the cognitive, psychomotor, and affective skills required for success in the plumbing trades. The 25 units are based on the curriculum alignment concept of first stating objectives, developing instructional strategies for teaching those objectives, and assessing those same objectives through criterion-referenced tests. Throughout the curriculum, materials are included to help students develop the academic and workplace skills and competencies identified by the Secretary's Commission on Achieving Necessary Skills and the American Society for Training and Development. The teacher guide begins with an overview of the curriculum and guide that includes the following: competency profile, instructional/task analysis; academic and workplace skills; related academic and workplace skills; tools, equipment, and materials list; and 10 references. Unit topics include the following: orientation to the occupation of plumber; tools and equipment; blueprints, measurements, and calculations; systems rough-in; residential systems; fixture and appliance installation; and system maintenance and repair. Each unit contains some or all of the following: suggested activities; assignment sheet answers; teacher supplements; written test and answers; unit evaluation form; and transparency masters. The matching student guide contains the objective, information, assignment, and job sheets for the same 25 units. (MN)

ED 424 411

Residential Plumbing
Third Edition

Teacher Edition
Student Edition

Multistate Academic and
Vocational Curriculum Consortium

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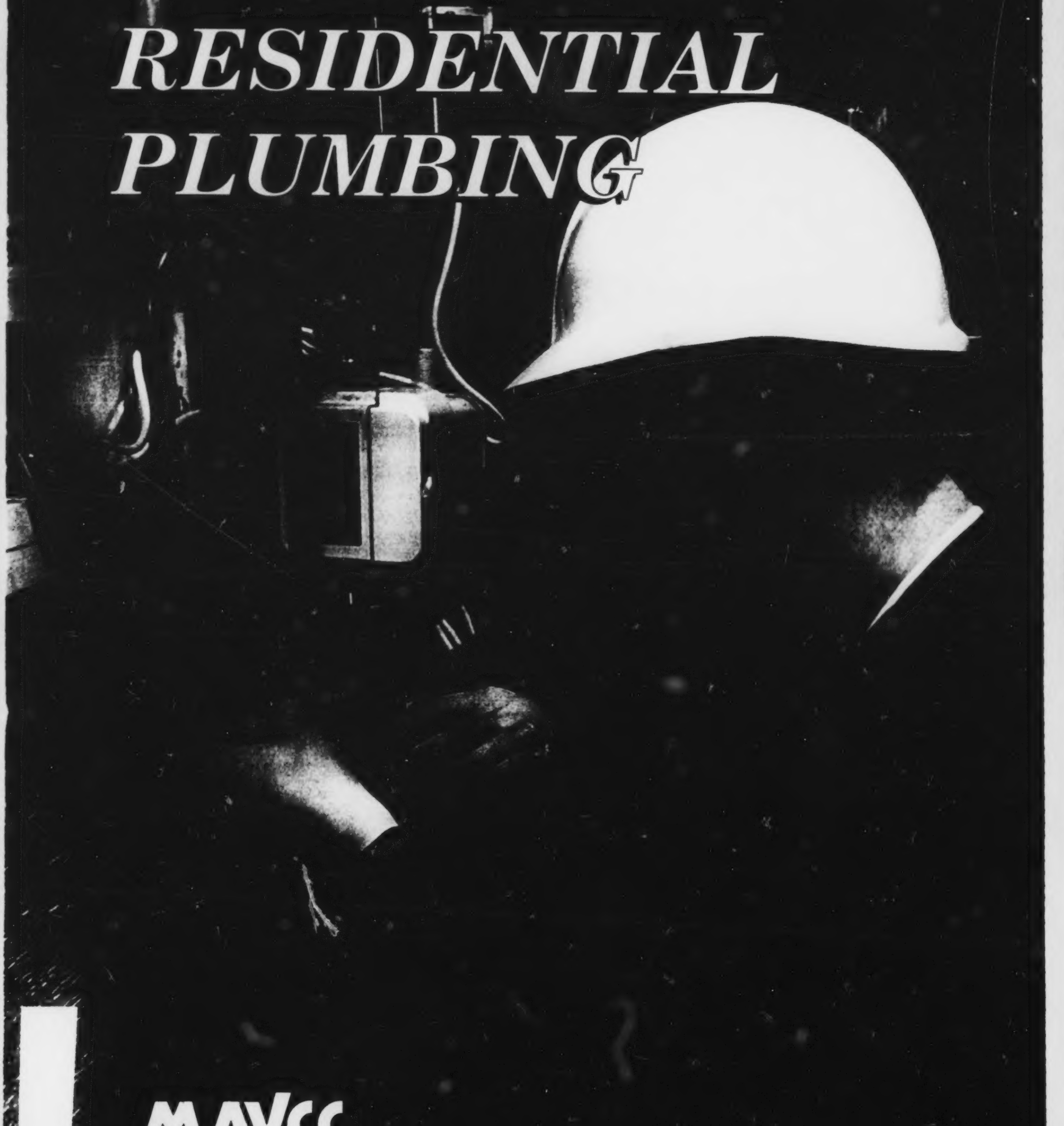

MAVCC

Multistate Academic and
Vocational Curriculum
Consortium

Teacher Edition

Residential Plumbing

Third Edition

Teacher Edition

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Residential Plumbing

Teacher Edition

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Foreword

When MAVCC began the process for revising *Residential Plumbing*, we wanted to develop instructional materials that would provide students with the cognitive (knowing), psychomotor (doing), and affective (attitude) skills necessary to be successful in the plumbing trade and that would address the emerging technology in the field. With the help of a technical expert and resources from plumbing suppliers and product manufacturers, this revised edition offers secondary and postsecondary students an excellent opportunity for learning essential skills in the plumbing industry.

These instructional materials are designed for student use and to assist teachers in organizing and improving instruction. Their design is based on the curriculum alignment concept of first stating the objectives (objective sheet), developing instructional strategies for teaching to those objectives (information, assignment, and job sheets), and assessing to those same objectives (criterion-referenced evaluation instruments).

As with all MAVCC publications, teachers are encouraged to localize and personalize these materials to meet the needs of individual students, the community, and prospective employers. Teachers are also encouraged to develop strategies for motivating their students.

A chart which classifies and defines each of the academic and workplace skills and competencies has been included in the teacher edition and reflects key elements from *What Work Requires of Schools: A SCANS Report for America 2000*, a 1991 study by the U.S. Department of Labor; *Workplace Basics: The Skills Employers Want*, a three-year study conducted jointly by the American Society for Training and Development (ASTD) and the United States Department of Labor (DOL); and other national and state sources. These tools have been provided in an effort to help educators identify and document where basic academic and workplace skills are being taught. By reinforcing these skills, the teacher should assist students in improving their employability skills.

Special attention should be given to the matrix identifying basic academic and workplace skills being reinforced in these instructional materials as well as the teacher suggestions on ways to reinforce these skills found in the teacher pages for each unit.

As you use these instructional materials, we hope that you will find that they contribute to the quality of your program. If any problems occur or if you have any suggestions for improvement of the materials, please call or write us.

Sue Ethelbah, Chair
MAVCC Board of Directors

Clark R. Harris
MAVCC Executive Director

Acknowledgements

Appreciation is extended to those individuals who contributed their time and talent to both the original development and to the revisions of *Residential Plumbing*.

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Use of Introductory Materials

Introductory materials are included in the teacher edition only and contain useful information to assist administrators and teachers in planning for instruction.

In addition to the general information such as the table of contents, foreword, and acknowledgements, information is included on the following:

1. **Use of this publication**—Explains the components of a unit of instruction and how they should be used as part of the teaching/learning process.
2. **Competency profile**—Provides a record of student performance for each task included in a unit of instruction. This becomes a part of the student's permanent records and should be utilized when directing the student toward employment opportunities.
3. **Instructional/task analysis**—Provides a quick review of contents of the publication; identifies cognitive (knowledge) skills and psychomotor (doing) skills addressed in each unit of instruction.
4. **Related academic and workplace skills list**—Classifies unit tasks (assignment sheets and job sheets) according to related academic and workplace skills and competencies being reinforced. Skill areas reflected by skill groups, sub skills, and definitions have been identified using *What Work Requires of Schools: A SCANS Report for America 2000* and *Workplace Basics: The Skills Employers Want.*
5. **Tools, equipment, and materials list**—Provides a comprehensive list of those items needed to successfully complete the assignment sheets and/or job sheets; assists administrator/teacher in determining program costs.
6. **Reference list**—Provides a comprehensive list of resources used in the development of this publication.

As you use these materials, it is hoped that they will provide useful information to meet a variety of needs.

Use of This Publication

Residential Plumbing contains twenty-five units of instruction. For the teacher edition, the pages are divided into teacher pages and student pages. These include the following:

Teacher Pages

Suggested Activities
Answers to Assignment Sheets*
Teacher Supplements*
Written Test
Answers to Written Test
Unit Evaluation Form
Transparency Masters*

Student Pages

Objective Sheet
Information Sheet
Student Supplements*
Assignment Sheets*
Job Sheets*

* *Designates components that may not appear in every unit of instruction*

The complete teacher edition consists of both teacher pages and student pages, as well as the introductory pages. Student pages focus on measurable and observable learning outcomes. Teacher pages provide evaluation tools and suggestions on ways to supplement, localize, personalize, and motivate in order to present a complete teaching/learning process.

MAVCC instructional materials are competency-based, not time-based. Students should be allowed to work until they master each competency.

Units of instruction are designed for use in more than one lesson or class period. Careful study of each unit of instruction by the teacher will help to determine the following:

- Amount of materials that can be covered in each class period
- Skills that must be demonstrated
- Amount of class time needed for demonstrations
- Amount of time needed for student practice and return demonstrations of mastered skills
- Supplies and equipment required for assignment sheets and job sheets
- Supplementary materials (videotapes, kits, reference books, etc.) that must be ordered
- Resource people who must be contacted

Suggested activities (teacher component)

The suggested activities assist teachers during the preparation stage of the teaching/learning process by providing an instructional plan, teaching suggestions, and a list of supplemental resources. Ways to integrate academic and workplace skills have been included in the teacher suggestions, and skill areas have been noted in bold. The teacher should read the suggested activities before teaching the units. Time should also be allowed to obtain supplemental materials, prepare audiovisual materials, and contact outside resources. Duties of the teacher will vary according to the particular unit.

Instructions for evaluating student performance on the job sheets are also included in the suggested-activities section. Teachers should select and discuss with students the rating scale that will be used.

To assist a teacher in obtaining suitable supplemental materials, references used in the development of each unit are listed in this component, along with suggested supplemental resources such as books, posters, pamphlets, videotapes, and computer software.

Answers to assignment sheets (teacher component)

These are designed to assist the teacher in evaluation of student performances.

Teacher supplements (teacher component)

Teacher supplements are optional materials for the teacher to use. They have three purposes: to provide the teacher with higher level materials to stretch the advanced student, with remedial information or practice to assist the less-advanced student, and with state-of-the-art information in which the teacher may not have background or with information that is not readily available in other books. Some teacher supplements may be duplicated for student use and are marked accordingly.

Written test (teacher component)

This component provides criterion-referenced evaluation of every cognitive objective listed in the unit of instruction. The written test may be duplicated for student use. If objectives have been added, deleted, or modified, appropriate changes should be made on the written test. Tests may be divided into shorter tests covering three or four objectives at a time and given soon after those objectives have been covered. A selection of test items from the units covered may be used for final tests at the end of each term if desired.

Answers to written test (teacher component)

These are designed to assist the teacher in evaluation of student performances.

Unit evaluation form (teacher component)

This sheet provides teachers with a record of each student's performance on a unit of instruction. It includes space for assignment sheet ratings, job sheet ratings, written test scores, and teacher comments. The unit evaluation form may be duplicated.

Transparency masters (teacher component)

Transparency masters are used to direct the students' attention to the topic of classroom discussion. They may provide illustrations, charts, schematics, or additional information needed to clarify and reinforce objectives included in the unit of instruction.

Objective sheet (student component)

Each unit of instruction is based on performance objectives which state the goals for successful completion of the course. These performance objectives are stated in two forms: unit objectives which state the expected performance of each student after completion of the unit of instruction, and specific objectives which state what the student must do to reach the unit objective.

The objectives should be stressed throughout the teaching/learning process. This will help answer any questions concerning performance requirements for each instructional unit. The objectives can also help determine teaching strategies and instructional methods. Teachers should prepare for each unit by deciding how each objective can best be taught.

Use of This Publication

Teachers should feel free to modify, delete, or add objectives in order to meet the needs of the students and community. When objectives are added, the teacher should remember to supply the needed information, assignment and/or job sheets, and criterion test items.

Information sheet (student component)

The information sheet provides the content essential for meeting the cognitive (knowledge) objectives of the unit. Teachers will find that the information sheet serves as an excellent guide for presenting background knowledge necessary to develop the skills specified in the unit objective. Students should read the information sheet before the information is discussed in class. Space is provided in margins for students and teachers to add notes that supplement, localize, personalize, or provide information for the teaching of each objective.

Student supplements (student component)

The information presented in a student supplement may consist of tables, charts, written information, forms, or other information students will need in order to complete one or more of the assignment and/or job sheets. Students are not directly tested over the information presented in a supplement; however, their ability to apply this information may be evaluated in the completion of assignment sheets and/or job sheets.

Assignment sheets (student component)

Assignment sheets provide students with paper and pencil activities that give students the opportunity to make practical application of the knowledge in the information sheet. Criteria are provided to objectively evaluate student performance.

Job sheets (student component)

Job sheets are an important segment of each unit. Job sheets provide potential employers with a picture of the skills being taught during training and the performances that might reasonably be expected from an individual who has had this training.

The job sheets provide criteria to objectively evaluate student performance, a list of required equipment and materials, and a step-by-step procedure for performing a psychomotor skill. The teacher should discuss the equipment and materials available in the classroom, laboratory, or shop and demonstrate the procedure prior to having students practice the procedure. When a student is ready to be evaluated, the teacher should follow instructions for evaluating student performance which may be found in the teacher edition (suggested activities component).

Residential Plumbing

Competency Profile

Name: ____

Directions: Evaluate the student using the rating scale below. Write the appropriate number to indicate the degree of competency achieved. The descriptions associated with each of the numbers focuses on a level of student performance for each of the tasks listed. The written test scoreline is provided for optional teacher use. It may not be applicable in all cases.

Option A

Rating scale:
4 – Skilled – Can perform job with no additional training
3 – Moderately Skilled – Has performed job during training program; limited additional training may be required.
2 – Limited Skill – Has performed job during training program; additional training is required to develop skill.
1 – Unskilled – Is familiar with process, but is unable to perform job.
0 – No Exposure – No information or practice provided during training program, complete training required.
NA – Non-applicable.

Option B

Yes – Can perform with no additional training
No – Is unable to perform satisfactorily

SECTION A: ORIENTATION

Unit 1-A: Occupational Introduction

_______ 1. Interview a plumber.
_______ 2. ____

_______Written Test Score

Unit 2-A: Applying for a Job

_______ 1. Write a resumé.
_______ 2. Write a letter of application for a plumbing job.
_______ 3. Complete an employment application form for a job as a plumber.
_______ 4. Practice interview questions.
_______ 5. Make an appointment by phone for a plumbing job interview.
_______ 6. Follow up an interview.
_______ 7. Evaluate a plumbing job offer.
_______ 8. Compare job opportunities.
_______ 9. ____

_______Written Test Score

Unit 3-A: General Safety and First Aid

_______ 1. Interpret a material safety data sheet.
_______ 2. Analyze problems related to shop safety and first aid.
_______ 3. Operate a fire extinguisher.
_______ 4. Lift a heavy object properly.
_______ 5. ____

_______Written Test Score

Competency Profile

SECTION B: TOOLS AND EQUIPMENT

Unit 1-B: Hand Tools

________ 1. Read a rule/tape measure.
________ 2. Measure lines to the nearest quarter, eighth, and sixteenth of an inch.
________ 3. Use hand tools to inspect/replace a washer on a globe valve.
________ 4. Measure and mark a predetermined length of pipe.
________ 5. Use hand tools to cut a length of steel pipe.
________ 6. Use hand tools to ream steel pipe.
________ 7. Use hand tools to cut pipe threads.
________ 8. Set up and use a hacksaw to cut a length of PVC pipe.
________ 9. ____

________Written Test Score

Unit 2-B: Power Tools

________ 1. Install a lavatory hanger on a concrete wall.
________ 2. Cut out a bathtub drain opening in a plywood floor.
________ 3. Thread steel pipe with a portable power-driven vise stand.
________ 4. ____

________Written Test Score

Unit 3-B: Equipment

________ 1. Light and adjust the air-acetylene torch.
________ 2. Set up and adjust the builder's level.
________ 3. Set up an inflatable rubber test plug in a pipe.
________ 4. Set up a mechanical test plug in a pipe.
________ 5. Set up and operate a ratchet lever hoist.
________ 6. ____

________Written Test Score

SECTION C: BLUEPRINTS, MEASUREMENTS, AND CALCULATIONS

Unit 1-C: Blueprint Reading

________ 1. Read the architect's scale at $^{1}/_{4}'' = 1'$.
________ 2. Read the architect's scale at $^{1}/_{8}'' = 1'$.
________ 3. Read the architect's scale at $1'' = 20'$.
________ 4. Read the architect's scale at $1'' = 50'$.
________ 5. Determine dimensions on a drawing using an architect's scale.
________ 6. ____

________Written Test Score

Unit 2-C: Sketches and Diagrams for Plumbers

________ 1. Develop three types of sketches of a drainage system in a basement floor.
________ 2. Develop an isometric sketch of a drainage system.
________ 3. ____

________Written Test Score

Competency Profile

Unit 3-C: Rough-In Locations

________ 1. Determine measurements from a manufacturer's specifications.
________ 2. Determine rough-in locations for a bathroom.
________ 3. Establish grade lines for installing plumbing.
________ 4. ____

________Written Test Score

Unit 4-C: Building and Plumbing Codes

________ 1. Apply code regulations to a plumbing installation.
________ 2. Use the BOCA Basic/National Plumbing Code.
________ 3. ____

________Written Test Score

Unit 5-C: Metric Measurement for Plumbers

________ 1. Read U.S. customary and metric rules.
________ 2. Convert English system measurements to metric measurements.
________ 3. ____

________Written Test Score

SECTION D: SYSTEMS ROUGH-IN

Unit 1-D: Drainage Systems

________ 1. Label a cross section of a P-trap.
________ 2. Identify fittings on a drainage system.
________ 3. Secure a permit for the installation of a plumbing system.
________ 4. Install a bathtub and overflow and trap on a two-story building.
________ 5. Install a prefabricated shower base drain (caulked method).
________ 6. Lay out trench lines.
________ 7. Calculate the slope required for building sewer lines.
________ 8. Install drain pipe in trenches.
________ 9. Install storm drains.
________10. Backfill trenches.
________11. Install pipe sleeves or thimbles through walls, ceilings, or floors.
________12. Install soil or waste back vents.
________13. Install cleanouts on drains.
________14. Rough-in waste lines and vents for built-in lavatories.
________15. Rough-in waste lines and vents for bathtubs.
________16. Secure horizontal and vertical lines of pipe to masonry surfaces with hangers.
________17. Secure horizontal and vertical lines of pipe to wood surfaces with hangers.
________18. Secure horizontal and vertical lines of pipe to metal surfaces with hangers.
________19. Install vent terminals (roof flashing).
________20. Inspect a plumbing system.
________21. ____

________Written Test Score

Competency Profile

Unit 2-D: Water Systems

_______ 1. Make an isometric drawing of a hot and cold water system for a two-story house.
_______ 2. Determine pipe sizes for a hot and cold water system for a two-story house.
_______ 3. Rough-in water supply lines for bathtubs.
_______ 4. Rough-in water supply lines for a water closet.
_______ 5. Rough-in water supply lines for a water heater.
_______ 6. Make water pressure tests on water supply systems.
_______ 7. _______________

_______Written Test Score

Unit 3-D: Joining Pipes

_______ 1. Cut, ream, thread, and join a piece of 1″ galvanized steel pipe to a 1″ fitting.
_______ 2. Join cast iron pipe to a cast iron fitting using a no-hub joint.
_______ 3. Join cast iron pipe to a cast iron fitting using a compression joint.
_______ 4. Cut, ream, and join copper tubing using the sweat method.
_______ 5. Cut, ream, and join copper tubing using a compression joint.
_______ 6. Cut, ream, and join copper tubing using a flare joint.
_______ 7. Cut, ream, and join copper tubing using a hammered flare joint.
_______ 8. Cut, ream, and join PVC pipe to a PVC fitting.
_______ 9. Cut, ream, and join flexible plastic pipe with insert fittings.
_______10. Join clay pipe with couplings.
_______11. Wipe clay pipe joints.
_______12. Cut cast iron soil pipe with snap-type chain cutter.
_______13. Bend copper tubing with a spring bender.
_______14. Thread steel pipe with an adjustable die.
_______15. Join cast iron pipe to clay pipe.
_______16. Join ductile iron pipe using the roll-grooved coupling method.
_______17. _______________

_______Written Test Score

Unit 4-D: Pipe Fittings

_______ 1. Read fitting sizes.
_______ 2. Identify fittings from a sketch of a piping system.
_______ 3. _______________

_______Written Test Score

Unit 5-D: Pipe

_______ 1. Construct a materials take-off list from an isometric drawing.
_______ 2. _______________

_______Written Test Score

Competency Profile

SECTION E: RESIDENTIAL SYSTEMS

Unit 1-E: Private Water Systems

________ 1. Compute the cost for plumbing supplies.
________ 2. Install a pump and controls according to manufacturer's specifications.
________ 3. ____

________Written Test Score

Unit 2-E: Septic Systems

________ 1. Install a septic tank.
________ 2. ____

________Written Test Score

Unit 3-E: Water Treatment

________ 1. Prepare a water sample for analysis by a state testing laboratory.
________ 2. ____

________Written Test Score

Unit 4-E: Fuel Piping Systems

________ 1. Size a gas pipe for residential construction.
________ 2. Perform leak tests on gas supply lines.
________ 3. ____

________Written Test Score

SECTION F: FIXTURE AND APPLIANCE INSTALLATION

Unit 1-F: Water Valves and Faucets

________ 1. Install a stop and waste valve (solder method).
________ 2. Install a kitchen sink faucet.
________ 3. Install a dual control lavatory faucet with pop-up drain plug.
________ 4. Disassemble and reassemble a single lever kitchen sink faucet
________ 5. ____

________Written Test Score

Unit 2-F: Drainage Connections

________ 1. Install a cast iron water closet flange.
________ 2. Install a plastic water closet flange.
________ 3. Install a brass to copper pipe water closet flange.
________ 4. Install a brass to lead pipe water closet flange.
________ 5. Install a lavatory trap.
________ 6. Install a kitchen sink trap.
________ 7. ____

________Written Test Score

Competency Profile

Unit 3-F: Fixtures and Appliances

_______ 1. Install a floor-mounted water closet.
_______ 2. Install a wall-mounted lavatory.
_______ 3. Install a recessed bathtub.
_______ 4. Install shower bath accessories in a ceramic tile bathroom.
_______ 5. Install an electric water heater.
_______ 6. Install a dishwasher.
_______ 7. Install a garbage disposal unit.
_______ 8. Install a gas water heater.
_______ 9. ______________________________

_______Written Test Score

SECTION G: SYSTEM MAINTENANCE AND REPAIR

Unit 1-G: Water Systems Maintenance and Repair

_______ 1. Install a prefabricated air chamber in a water supply line.
_______ 2. Replace a section of galvanized water supply line.
_______ 3. Thaw a frozen pipe with a plumber's torch.
_______ 4. Repair a leaking faucet.
_______ 5. Repair a leaking shower valve.
_______ 6. Replace a gas water heater.
_______ 7. Repair a ball cock on a water closet.
_______ 8. Replace a pressure control switch on a water pump.
_______ 9. Insulate water lines.
_______10. ______________________________

_______Written Test Score

Unit 2-G: Drainage Systems Maintenance and Repair

_______ 1. Replace a lavatory trap.
_______ 2. Clear obstructions from a lavatory drain.
_______ 3. Clear obstructions from a water closet drain.
_______ 4. Clear obstructions from a main drain line.
_______ 5. ______________________________

_______Written Test Score

COMMENTS: ______________________________

____

____

____

Evaluator: ______________________ Date: ______________

Permission to duplicate this profile is granted.

Residential Plumbing

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

SECTION A: ORIENTATION

Unit 1-A: Occupational Introduction

1. Terms and definitions
2. Job responsibilities of residential plumbers
3. Occupational fields related to plumbing
4. Reasons why there are occupational opportunities for residential plumbers now and in the future
5. Desirable personality traits and attitudes for residential plumbers
6. Reasons for teamwork
7. Conditions which enhance good customer relations
8. Distribution of income for a residential plumbing business
9. Interview a plumber

Unit 2-A: Applying for a Job

1. Terms and definitions
2. Employer expectations and employee expectations in their relationship
3. Means of locating job openings
4. Four methods of applying for a job
5. Personal attributes or attitudes an employer looks for during a personal interview
6. Four items an applicant may need to prepare when applying for a job
7. Guidelines to follow when interviewing for a job
8. Write a resumé
9. Write a letter of application for a plumbing job
10. Complete an employment application form for a job as a plumber
11. Practice interview questions
12. Make an appointment by phone for a plumbing job interview
13. Follow up an interview
14. Evaluate a plumbing job offer
15. Compare job opportunities

Instructional/Task Analysis

Unit 3-A: General Safety and First Aid

Related Information: What the Student Should Know

1. Terms and definitions
2. Things OSHA expects of an employer
3. Things OSHA expects of an employee
4. Basic first aid procedures for emergency situations
5. Colors of the safety color code and their applications
6. Rules for personal safety
7. Rules for general shop and field safety
8. Characteristics of a clean and orderly shop
9. Class of fire and their descriptions
10. Components of the fire triangle
11. Types of fire extinguishers and the classes of fire they are designed to extinguish
12. Fire extinguisher symbols and their meanings
13. Steps to be followed in case of an accident
14. Guidelines for lifting and carrying items safely
15. Purposes of a material safety data sheet (MSDS)

Application: What the Student Should Be Able to Do

16. Interpret a material safety data sheet
17. Analyze problems related to shop safety and first aid
18. Operate a fire extinguisher
19. Lift a heavy object properly

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

SECTION B: TOOLS AND EQUIPMENT

Unit 1-B: Hand Tools

1. Terms and definitions
2. Basic hand tools used in the plumbing trade
3. Proper use and care of hand tools
4. Safety precautions for handling and storing hand tools
5. Rules used for measuring
6. Guidelines for the use and care of rules and steel tapes

7. Read a rule/tape measure
8. Measure lines to the nearest quarter, eighth, and sixteenth of an inch
9. Use hand tools to inspect/replace a washer on a globe valve
10. Measure and mark a predetermined length of pipe
11. Use hand tools to cut a length of steel pipe
12. Use hand tools to ream steel pipe
13. Use hand tools to cut pipe threads
14. Set up and use a hacksaw to cut a length of PVC pipe

Unit 2-B: Power Tools

1. Terms and definitions
2. Power tools used in the plumbing trade
3. Use and care of power tools used in the plumbing trade
4. Safety precautions for power tools used in plumbing

5. Install a lavatory hanger on a concrete wall
6. Cut out a bathtub drain opening in a plywood floor
7. Thread steel pipe with a portable power-driven vise stand

Unit 3-B: Equipment

1. Terms and definitions
2. Equipment generally used in plumbing
3. Types of equipment and their correct use and care
4. Safety precautions related to operating an air-acetylene torch outfit

5. Light and adjust the air-acetylene torch
6. Set up and adjust the builder's level
7. Set up an inflatable rubber test plug in a pipe
8. Set up a mechanical test plug in a pipe
9. Set up and operate a ratchet lever hoist

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

SECTION C: BLUEPRINTS, MEASUREMENTS, AND CALCULATIONS

Unit 1-C: Blueprint Reading

1. Terms and definitions
2. Types of architectural drawings
3. Alphabet of lines
4. Floor plan and section drawing symbols
5. Plumbing, appliance, and structural symbols
6. Piping and fitting or valve symbols
7. Major items that should be included in a set of specifications
8. Finding specific information from a detailed specifications statement
9. Reading an architect's scale
10. Read the architect's scale at 1/4″ = 1′
11. Read the architect's scale at 1/8″ = 1′
12. Read the architect's scale at 1″ = 20′
13. Read the architect's scale at 1″ = 50′
14. Determine dimensions on a drawing using an architect's scale

Unit 2-C: Sketches and Diagrams for Plumbers

1. Characteristics of a plan view sketch
2. Characteristics of a riser diagram
3. Characteristics of an isometric sketch
4. Develop three types of sketches of a drainage system in a basement floor
5. Develop an isometric sketch of a drainage system

Unit 3-C: Rough-In Locations

1. Terms and definitions
2. Three individuals who could be responsible for determining rough-in locations
3. Verbal orders
4. Sketches
5. Marking out locations
6. Information commonly found on manufacturer's specifications

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 3-C: Rough-In Locations (cont.)

7. Information which can be determined from manufacturer's specifications
8. Residential construction tradesworkers
9. Cooperating and coordinating techniques between plumbers and other tradesworkers

10. Determine measurements from a manufacturer's specifications
11. Determine rough-in locations for a bathroom
12. Establish grade lines for installing plumbing

Unit 4-C: Building and Plumbing Codes

1. Terms and definitions
2. Membership of a plumbing code governing board, its authority, and its duties
3. Benefits of zoning laws, building codes, and plumbing codes
4. Major categories that should be included in a plumbing code
5. Basic principles of plumbing codes
6. Illegal fittings and installations

7. Apply code regulations to a plumbing installation
8. Use the BOCA Basic/National Plumbing Code

Unit 5-C: Metric Measurement for Plumbers

1. Terms and definitions
2. Common metric abbreviations
3. Convert approximate pipe sizes and lengths from the English system to the metric system
4. Convert temperature measurements from the English system to the metric system
5. Convert liquid measurements from the English system to the metric system
6. Convert weight (mass) measurements from the English system to the metric system

Instructional/Task Analysis

Related Information: What the Student Should Know | **Application: What the Student Should Be Able to Do**

Unit 5-C: Metric Measurement for Plumbers (cont.)

7. Calculate the volume of rectangular and cylindrical tanks
8. Convert cubic feet and inches to gallons

9. Read U.S. customary and metric rules
10. Convert English system measurements to metric measurements

SECTION D: SYSTEMS ROUGH-IN

Unit 1-D: Drainage Systems

1. Terms and definitions
2. Soil, waste, and vent pipes in a drainage system
3. Materials used in soil and waste pipes
4. Functions of soil, waste, and vent pipes in a drainage system
5. Purposes of plumbing traps
6. Types of traps
7. Various types of pipe hangers, clamps, and supports
8. Pipe hangers, clamps, and supports and their uses
9. Location, materials, and functions of building sewers and storm drains
10. Installation of building sewers and storm drains
11. Steps used when adding new plumbing to an old system during the planning and roughing-in stages
12. Water and air methods of testing drainage systems for leaks
13. Trenching techniques
14. Shoring materials and devices and their definitions
15. Safety precautions for various trenching hazards

16. Label a cross section of a P-trap
17. Identify fittings on a drainage system
18. Secure a permit for the installation of a plumbing system
19. Install a bathtub waste and overflow and trap on a two-story building
20. Install a prefabricated shower base drain (caulked method)
21. Lay out trench lines
22. Calculate the slope required for building sewer lines
23. Install drain pipe in trenches
24. Install storm drains
25. Backfill trenches
26. Install pipe sleeves or thimbles through walls, ceilings, or floors
27. Install soil or waste back vents
28. Install cleanouts on drains
29. Rough-in waste lines and vents for built-in lavatories
30. Rough-in waste lines and vents for bathtubs
31. Secure horizontal and vertical lines of pipe to masonry surfaces with hangers

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 1-D: Drainage Systems (cont.)

32. Secure horizontal and vertical lines of pipe to wood surfaces with hangers
33. Secure horizontal and vertical lines of pipe to metal surfaces with hangers
34. Install vent terminals (roof flashing)
35. Inspect a plumbing system

Unit 2-D: Water Systems

1. Terms and definitions
2. Components of a water system in a single-family dwelling and their functions
3. Factors to consider when installing a hot water system
4. Sizing of pipes in residential water systems
5. Materials used for pipes and materials used for valves in water pipe systems
6. Prevention of frozen pipes in cold weather
7. Preventing contamination of water systems by cross connections
8. Two methods of testing a water system for leaks
9. Make an isometric drawing of a hot and cold water system for a two-story house
10. Determine pipe sizes for a hot and cold water system for a two-story house
11. Rough-in water supply lines for bathtubs
12. Rough-in water supply lines for a water closet
13. Rough-in water supply lines for a water heater
14. Make water pressure tests on water supply systems

Unit 3-D: Joining Pipes

1. Terms and definitions
2. Tools, materials, and equipment necessary to join steel pipe
3. Tools, materials, and equipment necessary to join cast iron pipe by the compression and no-hub methods
4. Tools, materials, and equipment necessary to join copper tubing by the sweat joint, compression, and flare methods

Unit 3-D: Joining Pipes (cont.)

Related Information: What the Student Should Know

5. Tools, materials, and equipment necessary to join PVC and flexible plastic pipe
6. Tools, materials, and equipment necessary to join pipe by using the roll-grooved coupling method

Application: What the Student Should Be Able to Do

7. Cut, ream, thread, and join a piece of 1″ galvanized and steel pipe to a 1″ fitting
8. Join cast iron pipe to a cast iron fitting using a no-hub joint
9. Join cast iron pipe to a cast iron fitting using a compression joint
10. Cut, ream, and join copper tubing using the sweat method
11. Cut, ream, and join copper tubing using a compression joint
12. Cut, ream, and join copper tubing using a flare joint
13. Cut, ream, and join copper tubing using a hammered flare joint
14. Cut, ream, and join PVC pipe to a PVC fitting
15. Cut, ream, and join flexible plastic pipe with insert fittings
16. Join clay pipe with couplings
17. Wipe clay pipe joints
18. Cut cast iron soil pipe with snap-type chain cutter
19. Bend copper tubing with a spring bender
20. Thread steel pipe with an adjustable die
21. Join cast iron pipe to clay pipe
22. Join ductile iron pipe using the roll-grooved coupling method

Instructional/Task Analysis

Related Information: What the Student Should Know	Application: What the Student Should Be Able to Do

Unit 4-D: Pipe Fittings

1. Terms and definitions
2. Materials used to make pipe fittings and their specific uses, types, and properties
3. Basic plumbing branches
4. Basic plumbing bends
5. Basic unions and couplings
6. Basic caps and plugs
7. Basic bushings and nipples
8. Basic closet flanges and cleanouts
9. Basic no-hub fittings
10. Flexible plastic (PE) insert fittings
11. PVC-DWV fittings
12. Polybutylene fittings
13. Two types of malleable iron fittings
14. Four types of adapters
15. Read fitting sizes
16. Identify fittings from a sketch of a piping system

Unit 5-D: Pipe

1. Terms and definitions
2. Types of pipes used in residential plumbing
3. Types of copper pipes and their identification colors
4. Applications for types of pipe to be used in the plumbing trade
5. Black steel and galvanized steel pipe
6. Advantages and disadvantages of plastic pipe
7. Three common methods of measuring pipe
8. Construct a materials take-off list from an isometric drawing

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

SECTION E: RESIDENTIAL SYSTEMS

Unit 1-E: Private Water Systems

1. Terms and definitions
2. Types of private water supplies
3. Possible sources of contamination in private water supplies
4. Types of pumps used for private water systems
5. Operating principles of pumps used for private water systems
6. Pump controls used on private water systems
7. Applications of various pump controls on private water systems
8. Compute the cost for plumbing supplies
9. Install a pump and controls according to manufacturer's specifications

Unit 2-E: Septic Systems

1. Terms and definitions
2. Operation of a septic system
3. Basic design of a septic system
4. Septic tank construction materials
5. Septic tank care
6. Install a septic tank

Unit 3-E: Water Treatment

1. Terms and definitions
2. Five methods of disinfecting water
3. Probable causes of poor water quality symptoms
4. Poor water conditions and the means used to control them
5. Prepare a water sample for analysis by a state testing laboratory

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 4-E: Fuel Piping Systems

1. Terms and definitions
2. Materials for pipe, fittings, and valves which are commonly used in fuel piping systems
3. Methods of joining fuel piping for different types of materials
4. Basic principles of natural gas codes
5. Fuel piping testing methods
6. Size a gas pipe for residential construction
7. Perform leak tests on gas supply lines

SECTION F: FIXTURE AND APPLIANCE INSTALLATION

Unit 1-F: Water Valves and Faucets

1. Terms and definitions
2. Five types of valves
3. Parts of a globe valve
4. Parts of a gate valve
5. Parts of a check valve
6. Parts of a ball valve
7. Parts of a flush valve
8. Single and dual control faucets
9. Features of specific faucets
10. Install a stop and waste valve (solder method)
11. Install a kitchen sink faucet
12. Install a dual control lavatory faucet with pop-up drain plug
13. Disassemble and reassemble a single lever kitchen sink faucet

Unit 2-F: Drainage Connections

1. Terms and definitions
2. Various drainage connections used in residential plumbing
3. Ways a trap can lose its seal
4. Install a cast iron water closet flange
5. Install a plastic water closet flange
6. Install a brass to copper pipe water closet flange
7. Install a brass to lead pipe water closet flange
8. Install a lavatory trap
9. Install a kitchen sink trap

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 3-F: Fixtures and Appliances

1. Terms and definitions
2. Common fixtures and appliances used in residential plumbing
3. Fixtures and appliances and their installation requirements
4. Construction and materials used in the manufacture of common fixtures and appliances
5. Install a floor-mounted water closet
6. Install a wall-mounted lavatory
7. Install a recessed bathtub
8. Install shower bath accessories in a ceramic tile bathroom
9. Install an electric water heater
10. Install a dishwasher
11. Install a garbage disposal unit
12. Install a gas water heater

SECTION G: SYSTEM MAINTENANCE AND REPAIR

Unit 1-G: Water Systems Maintenance and Repair

1. Terms and definitions
2. Methods of thawing frozen pipes
3. Emergency repair methods for leaking pipes
4. Water closet tank malfunctions and their remedies
5. Install a prefabricated air chamber in a water supply line
6. Replace a section of galvanized water supply line
7. Thaw a frozen pipe with a plumber's torch
8. Repair a leaking faucet
9. Repair a leaking shower valve
10. Replace a gas water heater
11. Repair a ball cock on a water closet
12. Replace a pressure control switch on a water pump
13. Insulate water lines

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 2-G: Drainage Systems Maintenance and Repair

1. Terms and definitions
2. Types of equipment used to clear stoppages in plumbing fixtures
3. Cleanout access points in a drainage system
4. Replace a lavatory trap
5. Clear obstructions from a lavatory drain
6. Clear obstructions from a water closet drain
7. Clear obstructions from a main drain line

Academic and Workplace Skills (Classifications and Definitions)

Skill Group	Sub Skill	Description
Basic skills	Reading	Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task.
	Writing	Communicating a thought, idea, or fact in written form in a clear, concise manner.
	Arithmetic/ mathematics	Performing basic computations, applying estimating and reasoning skills, and solving practical problems using a variety of mathematical techniques.
	Science	Applying knowledge learned through study and practice that is based on scientific principles, methods, and techniques.
	Listening	Receiving, interpreting, and responding to verbal messages and other cues.
	Speaking	Communicating a thought, idea, or fact verbally in a clear, concise manner.
Thinking skills	Creative thinking	Using imagination to generate new ideas.
	Decision making	Specifying goals and constraints, generating alternatives, considering risks, and evaluating and choosing the best alternative.
	Problem solving	Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results.
	Seeing things in the mind's eye	Mentally organizing and processing symbols, pictures, graphs, and other information.
	Knowing how to learn	Using efficient learning techniques to acquire and apply new knowledge and skills.
	Reasoning	Applying a rule or principle underlying the relationship between two or more objects when solving a problem.
Personal-management skills	Responsibility	Exerting a high level of effort towards goal attainment, working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration.
	Self-esteem	Developing self-confidence and maintaining a positive view of self.
	Career awareness, development, and mobility	Assessing self accurately, setting personal goals, establishing and implementing a plan, and monitoring progress.
	Integrity/honesty	Choosing an ethical course of action when faced with making a decision that may break with personal or societal values and recognizing the impact of violating these beliefs and codes on an organization, self, and others.
	Organizational effectiveness	Adapting to the organization's goals, values, culture, and traditional modes of operation.

Academic and Workplace Skills and Competencies

Skill Group	Sub Skill	Description
Interpersonal skills	Teamwork	Working cooperatively with others to reach a common goal.
	Coaching	Helping others learn new skills.
	Leadership	Communicating ideas to justify position; accepting responsibility for others; and encouraging, persuading, convincing, or otherwise motivating an individual or group.
	Negotiation	Resolving conflict between two or more individuals through discussion and compromise.
	Customer service	Working and communicating with customers to satisfy their expectations.
	Cultural diversity	Working well with men and women with a variety of ethnic, social, or educational backgrounds.
Resources	Time	Selecting relevant, goal-related activities, ranking them in order of importance, allocating time, and understanding, preparing, and following schedules.
	Money	Using or preparing budgets, making forecasts, keeping records, and making adjustments to meet objectives.
	Material and facilities	Acquiring, storing, and using materials and space efficiently.
	Human resources	Assessing skills and distributing work accordingly; evaluating performance and providing feedback.
Information	Acquisition and evaluation	Identifying need for data, obtaining it from existing sources or creating it, and evaluating its relevance and accuracy.
	Organization and storage	Organizing, processing, and maintaining written or computerized records and other forms of information in a systematic way.
	Interpretation	Selecting and analyzing information and communicating the results to others.
	Processing	Using computers to acquire, organize, analyze, and communicate information.
Systems	Interrelationships	Knowing how social, organizational, and technological systems work and operate effectively.
	Monitoring	Distinguishing trends, predicting impact of actions on system operations, diagnosing deviations in systems' performance, and correcting malfunctions.
	Modification and design	Making suggestions to modify existing systems to improve products or services, and developing new or alternative systems.
Technology	Selection	Choosing procedures, tools, or equipment including computers and related technologies.
	Application	Demonstrating proper procedures for setting up and operating equipment.
	Maintenance and troubleshooting	Preventing, identifying, or solving problems with equipment, including computers and other technologies.

Related Academic and Workplace Skills For *Residential Plumbing*

Task	Skill Group	Sub Skill	Description
SECTION A: ORIENTATION			
Unit 1-A: Occupational Introduction			
Interview a plumber. (A.S. 1)	Basic skills	Reading	Follows written directions
		Writing	Communicates thoughts, ideas, or facts in written form
		Listening	Listens for content
		Speaking	Asks questions to obtain information
	Personal management skills	Career awareness	Identifies education and training needed to achieve goals
Unit 2-A: Applying for a Job			
Write a resume. (A.S. 1)	Basic skills	Reading	Comprehends written information and applies it to a task
		Writing	Uses language, organization, and format appropriate to purpose; produces neat, legible document
	Thinking skills	Reasoning	Extracts rules or principles from written information
Write a letter of application for a plumbing job. (A.S. 2)	Basic skills	Reading	Comprehends written information and applies it to a task
		Writing	Communicates thoughts, ideas, or facts in written form in a clear, concise manner; uses proper grammar, punctuation, and spelling
	Thinking skills	Reasoning	Extracts rules or principles from written information
Complete an employment application form for a job as a plumber. (A.S. 3)	Basic skills	Reading	Determines what information is needed; follows written directions
		Writing	Completes form accurately; writes legibly
	Personal management skills	Organizational effectiveness	Presents personal skills as benefits to company
Practice interview questions. (A.S. 4)	Basic skills	Reading	Comprehends written information for main ideas
		Listening	Listens for content
		Speaking	Speaks effectively using appropriate eye contact and posture
	Thinking skills	Reasoning	Determines which responses are appropriate
Make an appointment by phone for a plumbing job interview. (A.S. 5)	Basic skills	Reading	Analyzes and applies what has been read to a specific task
		Listening	Listens for content
		Speaking	Asks questions to obtain information; speaks in a clear, concise manner

Related Academic and Workplace Skills

Task	Skill Group	Sub Skill	Description
Unit 2-A: Applying for a Job (cont.)			
Follow up an interview. (A.S. 6)	Basic skills	Reading	Comprehends written information and applies it to a task
		Writing	Communicates thoughts, ideas, or facts in written form in a clear, concise manner; uses proper grammar, punctuation, and spelling
		Listening	Listens for content
		Speaking	Speaks in a clear, concise manner
Evaluate a plumbing job offer. (A.S. 7)	Basic skills	Reading	Comprehends written information for main ideas
		Writing	Presents answers in a clear and understandable form
	Thinking skills	Reasoning	Uses logic to draw conclusions from available information
Compare job opportunities. (A.S. 8)	Basic skills	Reading	Comprehends written information for main ideas
		Writing	Presents answers in a clear and understandable form
		Math	Calculates dollar amounts
	Thinking skills	Decision making	Identifies pros and cons to assist in decision making; evaluates information to make best decision
Unit 3-A: General Safety and First Aid			
Interpret a material safety data sheet. (A.S. 1)	Basic skills	Reading	Comprehends written information for main ideas; determines what information is needed
		Writing	Presents answers in a clear and understandable form
		Science	Applies scientific principles for safe handling of materials
	Thinking skills	Reasoning	Uses logic to draw conclusions from available information
Analyze problems related to shop safety and first aid. (A.S. 2)	Basic skills	Reading	Applies information and concepts derived from printed materials
		Writing	Presents answers in clear and understandable form
	Thinking skills	Problem solving	Recognizes/defines problem; identifies steps to solve problem
Operate a fire extinguisher. (J.S. 1)	Basic skills	Reading	Reads and follows instructions to operate equipment
	Resources	Material and facilities	Demonstrates proper use of safety device
Lift a heavy object properly. (J.S. 2)	Basis skills	Reading	Follows written directions; applies information to job performance
	Thinking skills	Knowing how to learn	Applies new knowledge and skills to tasks

Related Academic and Workplace Skills

Task	Skill Group	Sub Skill	Description
SECTION B: TOOLS AND EQUIPMENT			
Unit 1-B: Hand Tools			
Read a rule/tape measure. (A.S. 1)	Basic skills	Reading	Interprets drawings to obtain information
		Math	Applies mathematical principles to determine measurements
Measure lines to the nearest quarter, eighth, and sixteenth of an inch. (A.S. 2)	Basic skills	Reading	Follow written directions
		Math	Applies mathematical principles to determine measurements; measures specified lengths using a steel rule
Use hand tools to inspect/replace a washer on a globe valve. (J.S. 1)	Basic skills	Reading	Reads and follow directions to perform task
	Thinking skills	Problem solving	Recognizes/corrects problem
	Technology	Application	Demonstrates proper use of tools
Measure and mark a predetermined length of pipe. (J.S. 2)	Basic skills	Reading	Follows written directions
		Math	Applies mathematical principles to determine measurements; measures specified lengths using a steel rule
Use hand tools to cut a length of steel pipe. (J.S. 3)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools; follows safety procedures
Use hand tools to ream steel pipe. (J.S. 4)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools; follows safety procedures
Use hand tools to cut pipe threads. (J.S. 5)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools; follows safety procedures
Set up and use a hacksaw to cut a length of PVC pipe. (J.S. 6)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools; follows safety procedures

Related Academic and Workplace Skills

Task	Skill Group	Sub Skill	Description
Unit 2-B: Power Tools			
Install a lavatory hanger on a concrete wall. (J.S. 1)	Basic skills	Reading	Reads and follows directions to perform a specific task
		Math	Measures specified lengths using a steel rule
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools; follows safety procedures
Cut out a bathtub drain opening in a plywood floor. (J.S. 2)	Basic skills	Reading	Reads and follows directions to perform a specific task
		Math	Measures specified lengths using a steel rule
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools; follows safety procedures
Thread steel pipe with a portable power-driven vise stand. (J.S. 3)	Basic skills	Reading	Reads and follows directions to perform a specific task
		Math	Measures specified lengths using a steel rule
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility.	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools; follows safety procedures
Unit 3-B: Equipment			
Light and adjust the air-acetylene torch. (J.S. 1)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Set up and adjust the builder's level. (J.S. 2)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Technology	Application	Demonstrates proper use of tools and equipment

Related Academic and Workplace Skills

Unit 3-B: Equipment (cont.)

Task	Skill Group	Sub Skill	Description
Set up an inflatable rubber test plug in a pipe. (J.S. 3)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Set up a mechanical test plug in a pipe. (J.S. 4)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Set up and operate a ratchet lever hoist. (J.S. 5)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures

SECTION C: BLUEPRINTS, MEASUREMENTS, AND CALCULATIONS

Unit 1-C: Blueprint Reading

Task	Skill Group	Sub Skill	Description
Read the architect's scale at 1/4" = 1'. (A.S. 1)	Basic skills	Reading	Follows written directions
		Math	Reads measurements to scale
Read the architect's scale at 1/8" = 1'. (A.S. 2)	Basic skills	Reading	Follows written directions
		Math	Reads measurements to scale
Read the architect's scale at 1" = 20'. (A.S. 3)	Basic skills	Reading	Follows written directions
		Math	Reads measurements to scale
Read the architect's scale at 1" = 50'. (A.S. 4)	Basic skills	Reading	Follows written directions
		Math	Reads measurements to scale
Determine dimensions on a drawing using an architect's scale. (A.S. 5)	Basic skills	Reading	Follows written directions; Enterprets drawing to obtain factual information
		Writing	Records data from drawings
		Math	Makes precision measurements using a scale

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Related Academic and Workplace Skills

Task	Skill Group	Sub Skill	Description
Unit 2-C: Sketches and Diagrams for Plumbers			
Develop three types of sketches of a drainage system in a basement floor. (A.S. 1)	Basic skills	Reading	Follows written directions; analyzes and applies what has been read to a specific task
		Math	Applies mathematical principles to complete a drawing
Develop an isometric sketch of a drainage system. (A.S. 2)	Basic skills	Reading	Follows written directions; analyzes and applies what has been read to a specific task
		Math	Applies mathematical principles to complete a drawing; makes precision measurements using a scale
	Thinking skills	Seeing things in the mind's eye	Visualizes a system's operation to create drawing
Unit 3-C: Rough-In Locations			
Determine measurements from a manufacturer's specifications. (A.S. 1)	Basic skills	Reading	Interprets drawings to obtain factual information
		Writing	Records data from drawings
Determine rough-in locations for a bathroom. (J.S. 1)	Basic skills	Reading	Interprets drawings to obtain factual information; applies information to job performance; follows written directions
		Math	Makes precision measurements using a rule or tape
	Thinking skills	Reasoning	Applies rules and principles to a new situation
Establish grade lines for installing plumbing. (J.S. 2)	Basic skills	Reading	Interprets drawings to obtain factual information; applies information to job performance; follows written directions
		Math	Makes precision measurements using a rule or tape
	Thinking skills	Reasoning	Applies rules and principles to a new situation
Unit 4-C: Building and Plumbing Codes			
Apply code regulations to a plumbing installation. (A.S. 1)	Basic skills	Reading	Locates pertinent information in documents; follows written directions
Use the BOCA Basic/National Plumbing Code. (A.S. 2)	Basic skills	Reading	Locates pertinent information in documents; follows written directions
Unit 5-C: Metric Measurement for Plumbers			
Read U.S. customary and metric rules. (A.S. 1)	Basic skills	Reading	Applies what has been read to a specific task; follows written directions
		Math	Applies mathematical principles to read rules
Convert English system measurements to metric measurements. (A.S. 2)	Basic skills	Reading	Applies information and concepts derived from printed materials; follows written directions
		Math	Applies a mathematical formula to solve a problem; converts different units of measurement

Related Academic and Workplace Skills

SECTION D: SYSTEMS ROUGH-IN

Unit 1-D: Drainage Systems

Task	Skill Group	Sub Skill	Description
Label a cross section of a P-trap. (A.S. 1)	Basic skills	Reading	Follows written directions
		Writing	Records information on drawing
Identify fittings on a drainage system. (A.S. 2)	Basic skills	Reading	Recalls important details from written information and illustrations; follows written directions
		Writing	Writes/prints legibly
Secure a permit for the installation of a plumbing system. (A.S. 3)	Basic skills	Reading	Analyzes and applies what has been read to a specific task; follows written directions
		Writing	Completes form accurately and writing is legible
	Thinking skills	Seeing things in the mind's eye	Visualizes a system's operation to create sketch
		Reasoning	Applies rules and principles to a new situation
Install a bathtub waste and overflow and trap on a two-story building. (J.S. 1)	Basic skills	Reading	Comprehends written information and applies it to a task; follows written directions
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Install a prefabricated shower base drain (caulked method). (J.S. 2)	Basic skills	Reading	Comprehends written information and applies it to a task; follows written directions
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Lay out trench lines. (J.S. 3)	Basic skills	Reading	Comprehends written information and applies it to a task; follows written directions
		Math	Takes accurate measurements using a steel tape
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Calculate the slope required for building sewer lines. (J.S. 4)	Basic skills	Reading	Identifies relevant information from blueprint; follows written directions

Related Academic and Workplace Skills

Task	Skill Group	Sub Skill	Description
Unit 1-D: Drainage Systems (cont.)			
		Math	Takes measurements using common measuring device
	Thinking skills	Reasoning	Applies rules and principles to a new situation
Install drain pipe in trenches. (J.S. 5)	Basic skills	Reading	Comprehends written information and applies it to a task; follows written directions
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Install storm drains. (J.S. 6)	Basic skills	Reading	Comprehends written information and applies it to a task; follows written directions
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Backfill trenches. (J.S. 7)	Basic skills	Reading	Comprehends written information and applies it to a task; follows written directions
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Install pipe sleeves or thimbles through walls, ceilings, or floors. (J.S. 8)	Basic skills	Reading	Identifies relevant information from blueprint; reads and follows directions to perform a specific task
		Math	Takes measurement using common measuring device
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules
	Technology	Application	Demonstrates proper use of tools; follows safety procedures
Install soil or waste back vents. (J.S. 9)	Basic skills	Reading	Identifies relevant information from blueprint; reads and follows directions to perform a specific task
		Math	Takes measurement using common measuring device

Related Academic and Workplace Skills

Task	Skill Group	Sub Skill	Description
Unit 1-D: Drainage Systems (cont.)			
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules
	Technology	Application	Demonstrates proper use of tools; follows safety procedures
Install cleanouts on drains. (J.S. 10)	Basic skills	Reading	Identifies relevant information from blueprint; reads and follows directions to perform a specific task
		Math	Takes measurement using common measuring device
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules
	Technology	Application	Demonstrates proper use of tools; follows safety procedures
Rough-in waste lines and vents for built-in lavatories. (J.S. 11)	Basic skills	Reading	Identifies relevant information from blueprint; reads and follows directions to perform a specific task
		Math	Takes measurement using common measuring device
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules
	Technology	Application	Demonstrates proper use of tools; follows safety procedures
Rough-in waste lines and vents for bathtubs. (J.S. 12)	Basic skills	Reading	Identifies relevant information from blueprint; reads and follows directions to perform a specific task
		Math	Takes measurement using common measuring device
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules
	Technology	Application	Demonstrates proper use of tools; follows safety procedures
Secure horizontal and vertical lines of pipe to masonry surfaces with hangers. (J.S. 13)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation

Related Academic and Workplace Skills

Task	Skill Group	Sub Skill	Description
Unit 1-D: Drainage Systems (cont.)			
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools; follows safety procedures
Secure horizontal and vertical lines of pipe to wood surfaces with hangers. (J.S. 14)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools; follows safety procedures
Secure horizontal and vertical lines of pipe to metal surfaces with hangers. (J.S. 15)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools; follows safety procedures
Install vent terminals (roof flashing). (J.S. 16)	Basic skills	Reading	Comprehends written information and applies it to a task; follows written directions
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Inspect a plumbing system. (J.S. 17)	Basic skills	Reading	Analyzes and applies what has been read to a specific task; identifies relevant specifications
		Writing	Presents conclusions in a clear and understandable form
	Thinking skills	Problem solving	Recognizes/defines problem; demonstrates logical reasoning in reaching a conclusion
	Information	Interpretation	Applies code requirements to inspect work for compliance

Related Academic and Workplace Skills

Unit 2-D: Water Systems

Task	Skill Group	Sub Skill	Description
Make an isometric drawing of a hot and cold water system for a two-story house. (A.S. 1)	Basic skills	Reading	Follows written directions; analyzes and applies what has been read to a specific task
		Math	Applies mathematical principles to complete a drawing
	Thinking skills	Seeing things in the mind's eye	Organizes and processes images
		Reasoning	Applies rules and principles to a new situation
Determine pipe sizes for a hot and cold water system for a two-story house. (A.S. 2)	Basic skills	Reading	Follows written directions
	Thinking skills	Reasoning	Applies rules and principles to a new situation
Rough-in water supply lines for bathtubs. (J.S. 1)	Basic skills	Reading	Reads and follows directions to perform a specific task
		Math	Measures specified lengths using a steel rule
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Rough-in water supply lines for a water closet. (J.S. 2)	Basic skills	Reading	Reads and follows directions to perform a specific task
		Math	Measures specified lengths using a steel rule
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Rough-in water supply lines for a water heater. (J.S. 3)	Basic skills	Reading	Reads and follows directions to perform a specific task
		Math	Measures specified lengths using a steel rule
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Make water pressure tests on water supply systems. (J.S. 4)	Basic skills	Reading	Reads and follows directions to perform a specific task

Related Academic and Workplace Skills

Task	Skill Group	Sub Skill	Description
Unit 2-D: Water Systems (cont.)			
	Thinking skills	Reasoning	Applies rules and principles to a new situation
		Problem solving	Draws conclusions from observations and evaluates conditions and gives possible solutions
	Technology	Application	Demonstrates proper use of tools and equipment
Unit 3-D: Joining Pipes			
Cut, ream, thread, and join a piece of 1″ galvanized steel pipe to a 1″ fitting. (J.S. 1)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Join cast iron pipe to a cast iron fitting using a no-hub joint. (J.S. 2)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Join cast iron pipe to a cast iron fitting using a compression joint. (J.S. 3)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Cut, ream, and join copper tubing using the sweat method. (J.S. 4)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Cut, ream, and join copper tubing using a compression joint. (J.S. 5)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation

Related Academic and Workplace Skills

Task	Skill Group	Sub Skill	Description
Unit 3-D: Joining Pipes (cont.)			
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Cut, ream, and join copper tubing using a flare joint. (J.S. 6)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Cut, ream, and join copper tubing using a hammered flare joint. (J.S. 7)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Cut, ream, and join PVC pipe to a PVC fitting. (J.S. 8)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Cut, ream, and join flexible plastic pipe with insert fittings. (J.S. 9)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Join clay pipe with couplings. (J.S. 10)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures

Related Academic and Workplace Skills

Task	Skill Group	Sub Skill	Description
Unit 3-D: Joining Pipes (cont.)			
Wipe clay pipe joints. (J.S. 11)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Cut cast iron soil pipe with snap-type chain cutter. (J.S. 12)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Bend copper tubing with a spring bender. (J.S. 13)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Thread steel pipe with an adjustable die. (J.S. 14)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Join cast iron pipe to clay pipe. (J.S. 15)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Join ductile iron pipe using the roll-grooved coupling method. (J.S. 16)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation

Related Academic and Workplace Skills

Task	Skill Group	Sub Skill	Description
Unit 3-D: Joining Pipes (cont.)			
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Unit 4-D: Pipe Fittings			
Read fitting sizes. (A.S. 1)	Basic skills	Reading	Analyzes and applies what is read to a specific task; follows written directions
	Thinking skills	Reasoning	Applies rules and principles to a new situation
Identify fittings from a sketch of a piping system. (A.S. 2)	Basic skills	Reading	Follows written directions
	Thinking skills	Reasoning	Determines which conclusions are correct
Unit 5-D: Pipe			
Construct a materials take-off list from an isometric drawing. (A.S. 1)	Basic skills	Reading	Follows written directions; interprets drawing to obtain information
	Thinking skills	Reasoning	Uses logic to draw conclusions from available information
	Resources	Material and facilities	Identifies materials needed to complete task
SECTION E: RESIDENTIAL SYSTEMS			
Unit 1-E: Private Water Systems			
Compute the cost for plumbing supplies. (A.S. 1)	Basic skills	Reading	Identifies relevant details, facts, and specifications; follows written directions
		Math	Performs basic computations; calculates dollar amounts
	Thinking skills	Reasoning	Uses logic to draw conclusions from available information
	Resources	Money	Estimates cost of materials to complete a task
	Information	Acquisition and evaluation	Acquires information from existing resources
Install a pump and controls according to manufacturer's specifications. (J.S. 1)	Basic skills	Reading	Reads and follows directions to perform a specific task
		Math	Takes measurements using a common measuring device
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures

Related Academic and Workplace Skills

Task	Skill Group	Sub Skill	Description
Unit 2-E: Septic Systems			
Install a septic tank. (J.S. 1)	Basic skills	Reading	Reads and follows directions to perform a specific task
		Math	Measures specified lengths using a steel rule
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules
	Information	Interpretation	Applies code requirements to work situation
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Unit 3-E: Water Treatment			
Prepare a water sample for analysis by a state testing laboratory. (J.S. 1)	Basic skills	Reading	Reads and follows directions to perform a specific task
		Science	Prepares a sample for testing as specified
Unit 4-E: Fuel Piping Systems			
Size a gas pipe for residential construction. (A.S. 1)	Basic skills	Reading	Uses tables to obtain factual information; interprets diagrams to obtain factual information; reads and follows directions to perform a specific task
		Math	Measures specified lengths using a steel rule
	Thinking skills	Problem solving	Demonstrates logical reasoning in reaching a conclusion
Perform leak test on gas supply lines. (J.S. 1)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
SECTION F: FIXTURE AND APPLIANCE INSTALLATION			
Unit 1-F: Water Valves and Faucets			
Install a stop and waste valve (solder method). (J.S. 1)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures

Related Academic and Workplace Skills

Task	Skill Group	Sub Skill	Description
Unit 1-F: Water Valves and Faucets (cont.)			
Install a kitchen sink faucet. (J.S. 2)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Install a dual control lavatory faucet with pop-up drain plug. (J.S. 3)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Disassemble and reassemble a single lever kitchen sink faucet. (J.S. 4)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Unit 2-F: Drainage Connections			
Install a cast iron water closet flange. (J.S. 1)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Install a plastic water closet flange. (J.S. 2)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Install a brass to copper pipe water closet flange. (J.S. 3)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures

Related Academic and Workplace Skills

Task	Skill Group	Sub Skill	Description
Unit 2-F: Drainage Connections (cont.)			
Install a brass to lead pipe water closet flange. (J.S. 4)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Install a lavatory trap. (J.S. 5)	Basic skills	Reading	Reads and follows directions to perform a specific task
		Math	Measures specified lengths using a steel rule
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Install a kitchen sink trap. (J.S. 6)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Personal management skills	Responsibility	Observes safety rules; wears safety equipment
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Unit 3-F: Fixtures and Appliances			
Install a floor-mounted water closet. (J.S. 1)	Basic skills	Reading	Reads and follows directions to perform a specific task
		Math	Measures specified lengths using a steel rule
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Information	Acquisition and evaluation	Follows manufacturer's specifications for installation
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Install a wall-mounted lavatory. (J.S. 2)	Basic skills	Reading	Reads and follows directions to perform a specific task
		Math	Measures specified lengths using a steel rule
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Information	Acquisition and evaluation	Follows manufacturer's specifications for installation
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures

Related Academic and Workplace Skills

Task	Skill Group	Sub Skill	Description
Unit 3-F: Fixtures and Appliances (cont.)			
Install a recessed bathtub. (J.S. 3)	Basic skills	Reading	Reads and follows directions to perform a specific task
		Math	Measures specified lengths using a steel rule
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Information	Acquisition and evaluation	Follows manufacturer's specifications for installation
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Install shower bath accessories in a ceramic tile bathroom. (J.S. 4)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Information	Acquisition and evaluation	Follows manufacturer's specifications for installation
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Install an electric water heater. (J.S. 5)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
		Problem solving	Draws conclusions from observations and evaluates conditions to find solution
	Information	Acquisition and evaluation	Follows manufacturer's specifications for installation
		Interpretation	Applies code requirements to inspect work for compliance
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Install a dishwasher. (J.S. 6)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
		Problem solving	Draws conclusions from observations and evaluates conditions to find solution
	Information	Acquisition and evaluation	Follows manufacturer's specifications for installation
		Interpretation	Applies code requirements to inspect work for compliance
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures

Related Academic and Workplace Skills

Task	Skill Group	Sub Skill	Description
Unit 3-F: Fixtures and Appliances (cont.)			
Install a garbage disposal unit. (J.S. 7)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Information	Acquisition and evaluation	Follows manufacturer's specifications for installation
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Install a gas water heater. (J.S. 8)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
		Problem solving	Draws conclusions from observations and evaluates conditions to find solution
	Information	Acquisition and evaluation	Follows manufacturer's specifications for installation
		Interpretation	Applies code requirements to inspect work for compliance
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures

SECTION G: SYSTEM MAINTENANCE AND REPAIR

Unit 1-G: Water Systems Maintenance and Repair

Task	Skill Group	Sub Skill	Description
Install a prefabricated air chamber in a water supply line. (J.S. 1)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Replace a section of galvanized water supply line. (J.S. 2)	Basic skills	Reading	Reads and follows directions to perform a specific task
		Math	Measures specified lengths using a steel rule
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Thaw a frozen pipe with a plumber's torch. (J.S. 3)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
		Problem solving	Evaluates conditions to solve problem
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures

Related Academic and Workplace Skills

Task	Skill Group	Sub Skill	Description
Unit 1-G Water Systems Maintenance and Repair (cont.)			
Repair a leaking faucet. (J.S. 4)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Repair a leaking shower valve. (J.S. 5)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Replace a gas water heater. (J.S. 6)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
		Problem solving	Draws conclusions from observations and evaluates conditions
	Information	Acquisition and evaluation	Follows manufacturer's specifications for installation
		Interpretation	Applies code requirements to inspect work for compliance
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Repair a ball cock on a water closet. (J.S. 7)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Replace a pressure control switch on a water pump. (J.S. 8)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Insulate water lines. (J.S. 9)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures

Related Academic and Workplace Skills

Task	Skill Group	Sub Skill	Description
Unit 2-G: Drainage Systems Maintenance and Repair			
Replace a lavatory trap. (J.S. 1)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
		Problem solving	Draws conclusions from observations and evaluates conditions
	Information	Acquisition and evaluation	Follows manufacturer's specifications for installation
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Clear obstructions from a lavatory drain. (J.S. 2)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
		Problem solving	Draws conclusions from observations and evaluates conditions
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Clear obstructions from a water closet drain. (J.S. 3)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
		Problem solving	Draws conclusions from observations and evaluates conditions
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures
Clear obstructions from a main drain line. (J.S. 4)	Basic skills	Reading	Reads and follows directions to perform a specific task
	Thinking skills	Reasoning	Applies rules and principles to a new situation
		Problem solving	Draws conclusions from observations and evaluates conditions
	Technology	Application	Demonstrates proper use of tools and equipment; follows safety procedures

Residential Plumbing

Tools, Equipment, and Materials List

Acetylene tank valve wrench
Adjustable pliers: 12″, 10″
Adjustable stock and die
Adjustable wrench: 8″
Air chamber
Air compressor
Air volume control
Air-acetylene torch outfit
All-purpose wrench
Anchor bolts, assorted
Approximately 2′ of 1/2″ diameter copper tubing
Assorted 3/4″ galvanized iron nipples
  (2-6″, 2-5″, 1-4″, 2-3″)
Available stub of 3″ plastic PVC
Backhoe and operator
Ball cock
Ball peen hammer
Basin wrench
Basket strainer
Bath-shower valve
Bathtub (recessed, 5′)
Bench vise
Black iron pipe
Block, 2″x4″
Blueprints
Boiler drain
Bolts and nuts
Bottle cap, 3-5 ounce
Brass closet flange
Bucket
Bushings, assorted
Cast iron pipe, 4″ diameter
Cast iron pipe cutters
Cast iron water closet flange
Caulking tools and equipment:
  Furnace and propane tank
  Yarning iron
  Packing iron
  Flooring chisel
  Lead pot
  Ladle
  Oakum
  Lead
  Hammer
Caustic chemical
Charged hose (hose hooked up to a water source and with water in the hose) or another secondary means of extinguishment for backup
Chisel
Clamps
Clay pipe
Clean cloth
Cleaning solvent with brush or abrasive paper
Closet auger
Closet bolts (with bolt caps)
Closet flange (with screws, if wood floor)
Closet seat wrench
Closet supply pipe (with angle valve)
Cloth or plastic for floor protection
Code book
Combination pliers
Combination slip-joint pliers
Compression gasket, 4″
Compression type faucet
Copper tubing, type L
Copy of contract
Coupling
Die
Die stock
Dishwasher adapter sink tail piece
Drain pipe
Drilling machine, 3/8″
Drip pan
Drop cloth
Dual control kitchen faucet
Duct tape
Elbows, 1/2″ 45°
Electric drilling machine with drills
Electric saw
Electrical extension cord
Faucet (complete with drain plug)
Fittings
Flare nut wrench
Flaring tool and block
Flaring rule
Flat file
Flexible cable with auger
Folding rule
Foot valve, 3/4″
Furnace, lead pot, lead
Galvanized iron 90° elbow, 3/4″
Galvanized iron pipe, 3/4″
Galvanized iron plug, 3/4″
Galvanized iron unions, 3/4″
Galvanized tees, 3/4″
Garbage disposal unit
Garden hose
Gas pipe fittings and valves
Gas tank
Gas tank with wrench
Gasket lubricant with brush
Gate valve, 3/4″
Globe valve

Tools, Equipment, and Materials List

Gloves
Grooved coupling
Grooved coupling gasket
Grout
Hacksaw blade
Hacksaw frame
Hammer
Hand drilling machine and 1/8″ drill
Handle puller
Handsaw with miter box
Hangers
Heavy object such as a large pipe or bathtub
Hubless clay pipe, 6″ diameter
Insulation
Insulation cement
Joint lubricant
Kitchen sink, installed in counter, with faucet and basket strainer
Knife
Ladle
Large, heavy box
Lavatory (wall hung type)
Lavatory faucet with pop-up drain
Lavatory hanger
Lavatory with P trap
Lavatory, hung on wall with faucet and pop-up drain installed
Lead hammer
Level
Long-handled broom
Lower-back support belt
Lumber, 1″ x 4″
Male adapters, 3/4″
Manufacturer's specifications (rough-in book) for a tub, lavatory, and water closet
Marking soap
Masonry drill, 3/8″
Material to safely package bottle
Measuring tape, 100°
Medium-size screwdriver
Molly bolts
Nail puller
Nails
Neoprene gasket
Newspapers or other material to protect tub
Non-petroleum based lubricant
Notebook
Nylon line
Nylon string
Oil can (cutting oil)
P trap, 1 1/2″
(chrome plated brass tube, 17 gauge)
P trap with deep escutcheon, 1 1/2″
(chrome plated brass tube, 17 gauge)
Packing ring
Pan
Paper
Pencil
Phillips head screwdriver
Pipe
Pipe caps and plugs
Pipe compound
Pipe cutter
Pipe cutter with reamer
Pipe dope
Pipe fittings
Pipe hangers
Pipe joint compound
Pipe puller
Pipe straps and nails
Pipe threading equipment
Pipe vise
Pipe wrenches, 14″
Plastic closet flange
Plug wrench
Plumber's socket wrench set
Plunger
Pocket knife
Pointed shovel
Portable fire extinguisher for Class A fire
Portable power-driven vise stand
Power sewer auger with attachments
Pressure control
Pressure gauge
Pressure switch
Pressure tank
Proper materials, such as tub waste and overflow and trap
Pump
Putty
Putty knife
PVC fittings
PVC pipe
PVC solvent cement
PVC solvent cement with brush
PVC solvent cleaner
PVC straight male adapter, 1 1/2″
PVC cleaner with brush
PVC couplings
Ratchet lever hoist
Reamer
Reciprocating power saw
Relief valve
Relief valve (if piston pump is used)
Roof flange, 1 1/2″
Roll-grooved ductile iron pipe
Roll of string
Roll or roofing felt
Roll pipe groover

Tools, Equipment, and Materials List

- Roof drains
- Rope, chain, and/or sling
- Rough-in book
- Round file
- Rubber test plug
- Safety glasses, regular and colored
- Sand and cement
- Screwdriver
- Screws, lag bolts
- Seat-dressing tool
- Septic tank and top
- Set of flexible supply tubes with angle valves
- Set of open-end wrenches
- Shop towel
- Shower bath accessories
- Single lever kitchen sink faucet
- Sink
- Sledge hammer
- Slip nut with washer, 1 1/2" x 1 1/4"
- Snap-type chain cutter
- Soap
- Socket wrench
- Soldering tools and equipment:
  - Torch and tank outfit
  - Striker
  - Solder
  - Flux
  - Flux brush
  - Clean cloth
  - Sand cloth
  - Fitting brush
  - Safety glasses
- Solvent cement with brush
- Spanner wrench
- Speedy connectors, 3/8"
- Spring bender, 1/2"
- Sponge
- Spud wrench
- Stainless steel shield and clamp assembly
- Steel pipe
- Steel pipe nipple
- Steel union
- Steel washers, 3/8"
- Steel wool
- Stepladder, 6'
- Stem grease
- Stop and waste valve (brass)
- Straight head screwdriver
- Strainer wrench
- Strap wrench
- Stub of 4" cast iron pipe
- Tail pieces, 1 1/2"
- Tamp
- Tanks, 55 gallon
- Tank supports
- Tank wrench
- Tap water
- Tar compound
- Tee
- Temperature and pressure relief valve
- Test plug
- Testing apparatus
- Threaded rod
- Tin snips
- Tire pump
- Transit level and tripod
- Trap with washers and slipnuts
- Trowel
- Tub waste and overflow
- Tubing
- Tubing cutters: 1/2", 1 1/2", 2"
- Twist drill, 3/16"
- Valve seat
- Valve seat wrench
- Vent pipe, 3"
- Vent terminal (roof flashing)
- Vinyl shims
- Vise
- Vise-grip pliers
- Washer (new)
- Washers
- Water (for test)
- Water closet (complete bowl and tank)
- Water closet (tank type)
- Water closet connected to drain system
- Water closet seat
- Water heater
- Water pump with pressure control
- Wax seal
- Wheel pipe cutter
- Wiping cloth
- Wire
- Wire solder
- Wood plank to support pump (2" x 8")
- Wood screws, assorted
- Wooden stakes

Note: Additional tools, equipment, and materials may be required by the service manual or instructor.

Residential Plumbing

References

Barclay, Leney. *Residential Plumbing.* Revised by Hank Johnson. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1985.

Blankenbaker, Keith E. *Modern Plumbing.* South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.

The BOCA Basic/National Mechanical Code. Country Club Hills, IL: Building Officials and Code Administrators International, Inc.

Conoco/Dupont. *Make Safety and Health a Habit.* Houston: Conoco, Inc., 1987.

Delta Faucet Catalog. Indianapolis: Delta Faucet Company.

Family Medical Guide. Better Homes and Gardens Books. New York: Meredith Corp., 1993.

Henderson, G. E. *Planning for an Individual Water System.* Winterville, GA: American Association for Vocational Materials.

Manual for Septic Tank Practice. Public Health Service Publication No. 526. Washington, D.C.: U.S. Government Printing Office.

National Fuel Gas Code. Arlington: American Gas Association.

Standard Gas Code. Birmingham, AL: Southern Building Code Congress International, Inc.

Occupational Introduction
Unit 1-A

Unit Contents

Teacher Components **Page**

Suggested Activities 3
Written Test 5
Answers to Written Test 9
Unit Evaluation Form 11
Transparency Master 1—Distribution of Income for a Residential Plumbing Business 13

Student Components **Page**

Objective Sheet A-1
Information Sheet A-3
Assignment Sheet 1—Interview a Plumber A-9

Occupational Introduction
Unit 1-A

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resources Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Make a transparency from the transparency master included in this unit.
- Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

Unit Introduction

- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss the assignment sheet. Review with students the criteria for evaluation of this activity.

Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Discuss career opportunities in the plumbing field. **(Listening; speaking; and career awareness, development and mobility)**
- Discuss working conditions of the plumber. **(Listening; speaking; and career awareness, development, and mobility)**
- Discuss expected salary ranges for the qualified apprentice plumbers in your area. **(Listening; speaking; and career awareness, development, and mobility)**

Suggested Activities

- Invite a local plumbing contractor to the class to discuss job opportunities in your area. Encourage the students to prepare questions in advance. **(Listening; speaking; career awareness, development, and mobility; and information acquisition and evaluation)**
- Invite a local advisory committee member to the class to discuss job opportunities in your area. Encourage the students to prepare questions in advance. **(Listening; speaking; career awareness, development, and mobility; and information acquisition and evaluation)**
- Invite former students to the class to discuss their experiences and their opinion of job opportunities in the area. Encourage the students to prepare questions in advance. **(Listening; speaking; career awareness, development, and mobility; and information acquisition and evaluation)**
- Discuss the plumbing apprenticeship program in your area. **(Listening; speaking; and career awareness, development, and mobility)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.
- Make copies of the written test. Add or modify test items as needed.
- Give and evaluate written test.
- Compile the assignment sheet rating and written test scores on the Unit Evaluation Form. Include any additional assignments or supplemental activities that should be part of the unit evaluation.
- Meet individually with students to evaluate their progress through this unit of instruction, and indicate to them possible areas of improvement.
- Reteach and retest as required.

Resources Used in Developing This Unit

- Barclay, Leney. *Residential Plumbing.* Revised by Hank Johnson. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1985.
- Blankenbaker, Keith E. *Modern Plumbing.* South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.

Suggested Supplemental Resources

Print Media

- Farr, J. Michael. *Getting the Job You Really Want.* Indianapolis, IN: JIST Works, Inc., 1995.
- *Occupational Outlook Handbook*, 1996–97. Washington, DC: U.S. Department of Labor, Bureau of Labor Statistics.

Nonprint Media

- PlumbNet. The Interactive Plumbing Network. http://www.plumbnet.com.

Occupational Introduction
Unit 1-A

Written Test

Name ______________________ Date __________ Score __________

1. Match the terms on the right with the correct definitions.

_______ a. Attitude, interest and/or relationship of the customer in respect to the actions of any of the employees or employers of a sales business

_______ b. Person who installs all the plumbing systems in residential structures

_______ c. Work done by several persons with each doing a part but all giving attention to the efficiency of the whole project

_______ d. A master plumber who is licensed to perform plumbing work and who is legally capable of entering into contractual agreements with customers

_______ e. Person who is learning the trade through an organized program of on-the-job work experience and classroom/shop training

_______ f. Person who has worked as a journeyman plumber for five years before taking and passing the master plumber license exam

1. Apprentice plumber
2. Customer relations
3. Journeyman plumber
4. Master plumber
5. Plumbing contractor
6. Teamwork

2. List three job responsibilities of residential plumbers.

a. ____

b. ____

c. ____

3. Select the occupational fields related to plumbing from the following list by placing an "X" in the appropriate blanks.

_______ a. Salesperson

_______ b. Counter person

_______ c. Electrician

_______ d. Estimator

_______ e. Appliance repairer

Written Test

_______ f. Sales representative

_______ g. City firefighter

_______ h. Foundry worker

_______ i. Manufacturer's representative

_______ j. Inspector

_______ k. Building maintenance person

4. List four reasons why there are occupational opportunities for residential plumbers now and in the future.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

5. List eight desirable personality traits and attitudes for residential plumbers.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

   e. ______________________________

   f. ______________________________

   g. ______________________________

   h. ______________________________

6. Explain four reasons for teamwork.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

Written Test

7. Select conditions which enhance good customer relations by placing an "X" in the appropriate blanks.

   _______ a. Honesty

   _______ b. Fairness

   _______ c. Good salaries

   _______ d. Neatness and cleanliness

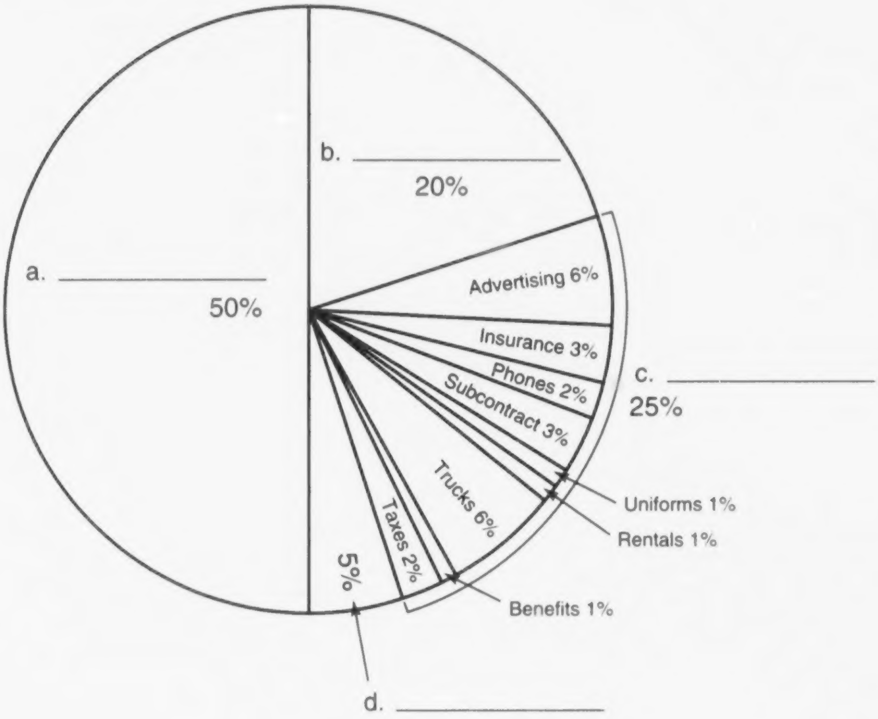
   _______ e. Courtesy and politeness

   _______ f. Demanding respect

   _______ g. Promptness

   _______ h. Effective communications

8. Complete the following chart showing the distribution of income for a residential plumbing business.



Permission to duplicate this test is granted.

Occupational Introduction
Unit 1-A

Answers to Written Test

1. a. 2
   b. 3
   c. 6
   d. 5
   e. 1
   f. 4

2. Any three of the following:
   a. Install drainage, vent, water, and gas supply pipes.
   b. Install plumbing fixtures and appliances.
   c. Perform maintenance work on existing plumbing systems.
   d. Effectively communicate with customers.

3. a, b, d, f, i, j, k

4. Any four of the following:
   a. Work is available due to continuing new home construction.
   b. Service and repair work is available due to prolonged use of plumbing installations.
   c. Work is available due to the continued standardization of practices through building codes, regulations, and testing.
   d. Work is available due to customer demand for modern plumbing systems.
   e. Work is available due to little automation in the construction field.
   f. Work is available through self-employment.

5. Any eight of the following:
   a. Adaptability
   b. Cooperation
   c. Courtesy
   d. Dependability
   e. Enthusiasm
   f. Honesty
   g. Initiative
   h. Loyalty
   i. Patience
   j. Self-control
   k. Tact

6. Any four of the following:
   a. Provides for the work to be done more quickly
   b. Provides for the work to be equally shared
   c. Provides for heavy loads to be handled more easily
   d. Provides for a degree of comradeship rather than isolation
   e. Provides for difficult jobs to be done more easily

7. a, b, d, e, g, h

8. a. Field costs
   b. Overhead
   c. Other expenses
   d. Profit

Occupational Introduction
Unit 1-A

Unit Evaluation Form

Student Name ______________________ Unit Rating ____________

Assignment Sheet Rating

Assignment Sheet 1—Interview a Plumber Rating ______

Comments: ____

____

____

Written Test Scores

Pretest ________ Posttest ________ Other ________

Other ____

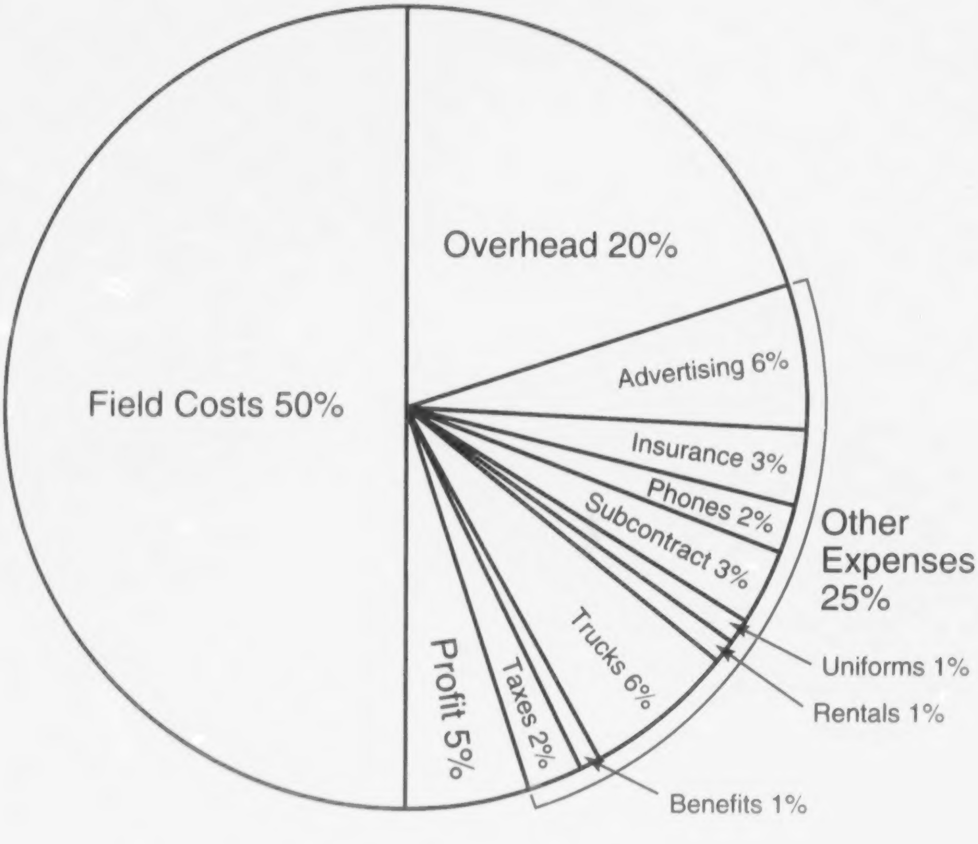
____

Teacher Signature ______________________ Date ____________

Student Signature ______________________ Date ____________

Permission to duplicate this form is granted.

Distribution of Income for a Residential Plumbing Business



TM 1

Applying for a Job
Unit 2-A

Unit Contents

Teacher Components **Page**

Suggested Activities 3
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Unit Evaluation Form 13
Transparency Master 1—Attitudes an Employer Looks for During a Personal Interview 15

Student Components **Page**

Objective Sheet A-11
Information Sheet A-13

Assignment Sheets

1—Write a Resumé A-21
2—Write a Letter of Application for a Plumbing Job A-25
3—Complete an Employment Application Form for a Job as a Plumber A-29
4—Practice Interview Questions A-33
5—Make an Appointment by Phone for a Plumbing Job Interview A-35
6—Follow Up an Interview A-37
7—Evaluate a Plumbing Job Offer A-41
8—Compare Job Opportunities A-43

Applying for a Job
Unit 2-A

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resource Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Make transparency from the transparency master included in this unit.
- Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

Unit Introduction

- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss the assignment sheets. Review with students the criteria for evaluation of these activities.

Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Have students prepare a self-inventory listing their education, experience, personal information, and school activities for use in choosing an occupation. **(Career awareness, development, and mobility; human resources; and information acquisition and evaluation)**

Suggested Activities

- Have students complete a plan for reaching their occupational objectives, including the education and experience needed to qualify for the position. **(Decision making; problem solving; and career awareness, development, and mobility)**

- Obtain want ads from newspapers in your area and discuss plumbing opportunities in your area. **(Reading; listening; speaking; career awareness, development, and mobility; and information acquisition and evaluation)**

- Prepare a bulletin board on plumbing employment opportunities. **(Reading; and career awareness, development, and mobility)**

- Invite resource person to discuss "What I look for on application letters, resumés, employment application forms, and follow-up devices" and "How do equal opportunity and affirmative action affect my hiring procedures?" **(Listening; career awareness, development, and mobility; and human resources)**

- Obtain letters of application and resumés to discuss characteristics of a good letter of application and resumé and to provide students with various formats that can be used in preparing their documents. **(Reading; listening; learning how to learn; and reasoning)**

- Provide students with wage and salary figures for plumbing positions in your area. **(Reading; and career awareness, development, and mobility)**

- Obtain videotape equipment to record students in practice interviews. Play back tapes and discuss positive and negative points with students. **(Listening; speaking; career awareness, development, and mobility; teamwork; and coaching)**

- Request a teletrainer from the local phone company for students to use in completing Assignment Sheets 5 and 6. **(Listening; speaking; career awareness, development, and mobility; teamwork; and coaching)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.

- Make copies of the written test. Add or modify test items as needed.

- Give and evaluate written test.

- Compile the assignment sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignments or supplemental activities that should be part of the unit evaluation.

- Meet individually with students to evaluate their progress through this unit of instruction and indicate to them possible areas of improvement.

- Reteach and retest as required.

Suggested Activities

Resource Used in Developing This Unit

- Barclay, Leney. *Residential Plumbing.* Revised by Hank Johnson. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1985.

Suggested Supplemental Resources

Print Media

- Blanchard, Kenneth H. *Raving Fans: A Revolutionary Approach to Customer Service.* New York: William Morrow Company, Inc., 1993.
- Bloch, Deborah Perlmutter. *How to Write a Winning Resumé.* Lincolnwood, IL: VGM Career Horizons, 1990.
- Farr, Michael J. *Getting the Job You Really Want.* Indianapolis: JIST Works, Inc., 1995.
- Farr, Michael J. *The Quick Interview and Salary Negotiation Book.* Indianapolis: JIST Works, Inc., 1995.
- Jackson, Tom. *Resumé Express.* New York: Random House, Inc., 1993.
- Krannich, Caryl and Ronald L. *Interview for Success: A Practical Guide to Increasing Job Interviews, Offers, and Salaries.* Woodbridge, VA: Impact Publications, 1990.
- Ludden, LaVern. *Job Savvy: How to Be a Success at Work.* Indianapolis: JIST Works, Inc., 1992.
- Nadler, Burton J. *Naked at the Interview: Tips and Quizzes to Prepare You for Your First Real Job.* New York: John Wiley and Sons, Inc., 1994.
- Scott, Dru. *Customer Satisfaction: The Other Half of Your Job.* Los Altos, CA: Crisp Publications, Inc., 1991.
- Zemke, Ron. *The Service Edge: 101 Companies that Profit from Customer Care.* New York: Penguin Books, 1990.

Nonprint Media

- *Multimedia Materials for Occupational, Vocational, and Career Education.* A catalog of teaching aids such as computer programs, film strips, cassettes, teacher guides, and workbooks from:

  Career Aids, Inc.
  8950 Lurline Avenue
  Department TE
  Chatsworth, CA 91311

  Examples:
  1. *Choosing Careers*
  2. *Job Readiness*
  3. *Introducing the Working World*
  4. *Finding and Keeping a Job*
  5. *Job Interview Kit*

Applying for a Job
Unit 2-A

Written Test

Name ______________________ Date ____________ Score ____________

1. Match terms on the right with the correct definitions.

_______ a. Brief, typed summary of one's qualifications and experience that is used in applying for a job

_______ b. Extras provided by an employer, such as paid vacations, sick leave, and insurance protection

_______ c. Recognition received for outstanding achievement

_______ d. Experience, education, and physical characteristics which suit a person to a job

_______ e. Any vocational courses and skills one has learned in school or through work experience

_______ f. Clubs, organizations, and social or church groups in which one participates

_______ g. To attach wages or other property to satisfy a debt

_______ h. Meeting of employer and job applicant for purpose of evaluation and questioning

_______ i. Printed form on which job applicants record information about their personal history, job history, job experience, education, and references

_______ j. Business designed to help individuals find employment

_______ k. Person employed by another, usually for wages or salary

_______ l. Classified advertising that does not identify the advertiser

_______ m. Classified advertisement placed by individuals seeking employment and telling what their qualifications are

_______ n. Classified advertisement telling what kind of job is available and what the qualifications are

_______ o. Capable of being read; clear

_______ p. Employer who is making a special effort to assure that no form of discrimination is practiced

_______ q. Person who employs others, usually for wages or salary

1. Award
2. Employee
3. Employer
4. Interview
5. Extracurricular activities
6. Fringe benefits
7. Application form
8. Qualifications
9. Resumé
10. Garnishee
11. Vocational preparation
12. Employment agency
13. Equal opportunity employer
14. Blind ad
15. Help wanted ad
16. Legible
17. Employment/situation wanted ad

Written Test

2. Distinguish between employer expectations and employee expectations in their relationship by placing an "X" next to employer expectations.

_______ a. Cooperation

_______ b. Initiative

_______ c. Safe working conditions

_______ d. Loyalty and respect

_______ e. Explanation of policy, rules, and regulations

_______ f. Discipline for breaking rules

_______ g. Acceptance of objective criticism

_______ h. Full day's work for a full day's pay

_______ i. Notification of termination

_______ j. Training

_______ k. Evaluation of work

_______ l. Dependability

_______ m. Productivity

3. List four means of locating job openings.

a. _______________

b. _______________

c. _______________

d. _______________

4. List four methods of applying for a job.

a. _______________

b. _______________

c. _______________

d. _______________

Written Test

5. Select personal attributes or attitudes an employer looks for during a personal interview by placing an "X" in the appropriate blanks.

_______ a. Alertness, quickness of mind

_______ b. Assertiveness

_______ c. Dedication and dependability

_______ d. Enthusiasm and interest

_______ e. Marital status

_______ f. Honesty and integrity

_______ g. Desire to work

_______ h. Flashy clothes

_______ i. Ability to work well with others

_______ j. Desire to improve skills

6. List four items which an applicant may need to prepare when applying for a job.

a. ____

b. ____

c. ____

d. ____

7. Select guidelines to follow when interviewing for a job by placing an "X" in the appropriate blanks.

_______ a. Take spouse or friends with you to job interview.

_______ b. Know facts about the business.

_______ c. Start the interview with a smile and greet the interviewer by name.

_______ d. Place personal things on interviewer's desk.

_______ e. Criticize former employers or competitors when applicable.

_______ f. Chew gum if you have bad breath.

_______ g. Answer all questions honestly.

_______ h. Ask questions about politics, economics, religion, and other controversial subjects.

_______ i. Look directly at the interviewer.

_______ j. Do not ask questions or show interest in the business.

_______ k. Thank the interviewer for his/her time.

_______ l. Write a thank you letter, call, or visit again to express interest in the job and appreciation for the opportunity to interview.

Permission to duplicate this test is granted.

Applying for a Job
Unit 2-A

Answers to Written Test

1.	a.	9	e.	11	i.	7	m.	17	q.	3
	b.	6	f.	5	j.	12	n.	15		
	c.	1	g.	10	k.	2	o.	16		
	d.	8	h.	4	l.	14	p.	13		

2. a, b, d, g, h, i, l, m

3. Any four of the following:
   a. Classified ads
      - Newspapers
      - Magazines
   b. Employment offices
      - State and federal government agencies
      - Private
   c. Local labor union business office
   d. School officials
      - Teacher
      - Counselor
      - Principal
   e. Plumbers working in your area
   f. Friends and neighbors
   g. Former employers
   h. Plumbing supply dealers
   i. Internet
      - Company job listings
      - Job search websites

4. a. Letter
   b. Telephone
   c. In person
   d. Internet, e-mail

5. a, c, d, f, g, i, j

6. a. Resumé
   b. Letter of application
   c. Application form
   d. Follow-up letter

7. b, c, g, i, k, l

Applying for a Job
Unit 2-A

Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Assignment Sheet Ratings

Assignment Sheet 1—Write a Resumé Rating ______

Comments: ______________________

____

Assignment Sheet 2—Write a Letter of Application for a Plumbing Job Rating ______

Comments: ______________________

____

Assignment Sheet 3—Complete an Employment Application Form for a Job as a Plumber Rating ______

Comments: ______________________

____

Assignment Sheet 4—Practice Interview Questions Rating ______

Comments: ______________________

____

Assignment Sheet 5—Make an Appointment by Phone for a Plumbing Job Interview Rating ______

Comments: ______________________

____

Assignment Sheet 6—Follow Up an Interview Rating ______

Comments: ______________________

____

Unit Evaluation Form

Assignment Sheet 7—Evaluate a Plumbing Job Offer Rating ________

Comments: ______________________________

____

Assignment Sheet 8—Compare Job Opportunities Rating ________

Comments: ______________________________

____

Written Test Scores

Pretest ________ Posttest ________ Other ________

Other ______________________________

____

Teacher Signature ______________ Date ________

Student Signature ______________ Date ________

Permission to duplicate this form is granted.

Attitudes an Employer Looks for During a Personal Interview

Enthusiasm, Interest, Dedication, Dependability, Alertness, Quickness of mind, Honesty, Integrity, Desire to work, Ability to work well with others, Desire to improve skills

General Safety and First Aid
Unit 3-A

Unit Contents

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General Safety and First Aid
Unit 3-A

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resources Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Make transparencies from the transparency masters included in this unit.
- Review "Instructions for Evaluating Student Performance."
- Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

Unit Introduction

- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss the assignment sheets. Review with students the criteria for evaluation of these activities.
- Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and materials are available. Review criteria for evaluation of these activities.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Have students make safety posters for use in the shop area. **(Writing; thinking; seeing things in the mind's eye; and information interpretation)**
- Make a safety checklist for students to use in the shop area. **(Reading; and reasoning)**
- Discuss common safety violation scenarios in addition to the ones included in the assignment sheet. **(Listening; speaking; decision making; and reasoning)**
- Invite a member of the local fire department to demonstrate the proper use of several types of fire extinguishers. Have the department help establish a safe area where the students can learn to put out fires for Job Sheet 1 in this unit. **(Listening; material and facilities; and application)**
- Invite a Red Cross instructor, EMT, or rescue team member to discuss and demonstrate proper first aid procedures. Have the students practice these procedures. **(Listening; and teamwork)**
- Demonstrate proper lifting techniques, following the steps listed in the Information Sheet. **(Listening)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.
- Make copies of the written test. Add or modify test items as needed.
- Give and evaluate written test.
- Compile the assignment sheet ratings, job sheet ratings, and written test scores on the Unit Evaluation Form. Include any additional assignments or supplemental activities that should be part of the unit evaluation.
- Meet individually with students to evaluate their progress through this unit of instruction and indicate to them possible areas of improvement.
- Reteach and retest as required.

Suggested Activities

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation — Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation — Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

Resources Used in Developing This Unit

- Barclay, Leney. *Residential Plumbing.* Revised by Hank Johnson. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1985.
- Conoco/Dupont. *Make Safety and Health a Habit.* Houston: Conoco, Inc., 1987.
- *Family Medical Guide.* Better Homes and Gardens Books. New York: Meredith Corp., 1993.

Suggested Supplemental Resources

Print Media

- *Fire Service First Responder.* Stillwater, OK: International Fire Service Training Association/Fire Protection Publications, 1987.
- *MSDS Pocket Dictionary.* Schenectady, NY: Genium Publishing Corp., 1989.

Suggested Activities

Nonprint Media

- National Safety Council, Public Relations Department, 1121 Spring Lake Drive, Itasca, IL 60143–3201. Phone: (708) 775-2307. (Publications and audio-visual material.)
- REACT Series of first aid and safety color videos available in 1/2 inch VHS format from Coronet Films, 65 E. South Water Street, Chicago, IL 60601. Phone: (800) 621-2131.

General Safety and First Aid
Unit 3-A

Answers to Assignment Sheets

Assignment Sheet 1—Interpret a Material Safety Data Sheet

1. Pipe thread sealant
2. None
3. Black paste
4. >400°F
5. Foam, dry chemical, CO_2, or water fog
6. Rupture
7. No
8. Through the skin or through ingestion
9. Skin—irritation or rash; eyes—irritation, watering; ingestion—nausea and vomiting
10. Do not give anything by mouth or attempt to induce vomiting.
11. Keep container closed and upright when not in use; do not store near heat, sparks, or open flame; do not store >150°F.
12. Strong oxidizing agents
13. Dispose of in controlled incineration facilities in accordance with all local, state, and federal regulations.
14. No
15. Wear non-permeable protective gloves, goggles, and coveralls; avoid contact with skin and clothing.
16. Wash exposed areas thoroughly before eating, drinking, smoking, or leaving work area.

Assignment Sheet 2—Analyze Problems Related to Shop Safety and First Aid

Part A

1. Wear gloves when handling material with sharp edges; conduct yourself in a safe manner at all times.
2. Keep the shop or job-site floor clean of scraps and litter.
3. Use a solvent only after determining its properties, what kind of work it has to do, and how to use it; consider the safety of others when working in the shop; conduct yourself in a safe manner at all times.

4. Consider the safety of others when working in the shop; do not throw tools or other objects; conduct yourself in a safe manner at all times.

5. Always check the source of the fire; never use conductive extinguishing agents on an electrical fire; do not touch the victim until all electrical power has been cut off.

Part B

1. Survey the area; check for injury and provide first aid as appropriate; do not move victim or allow victim to move if neck or back injury is suspected.

2. Third-degree burn; cool with damp compress and then cover with a dry sterile dressing; cover the victim with a blanket, elevate feet and legs to prevent shock and loss of body heat; always wear protective clothing including gloves while welding.

General Safety and First Aid
Unit 3-A

Written Test

Name ______________________ Date ____________ Score ____________

1. Match terms on the right with the correct definitions.

______ a. Immediate, temporary care given to the victim of an accident or sudden illness until the services of a physician can be obtained

______ b. State or condition of being safe; freedom from danger, risk, or injury

______ c. Any suddenly occurring, unintentional event which causes injury or property damage

______ d. Failure to think before one acts; failure to pay attention

______ e. Burn affecting only the outer skin layers; characterized by redness and pain

______ f. Electrical connection to an object that conducts electrical current to the earth

______ g. Stoppage of the involuntary beating of the heart

______ h. Federal legislation designed to insure safe and sanitary working conditions for employees

______ i. Burn penetrating beneath the superficial skin layers; characterized by swelling and blisters

______ j. Medical condition in which the operation of the circulatory system is partially or completely impaired by the body's reaction to injury or psychic disturbance

______ k. Procedure for restoring breathing after cardiac arrest

______ l. Burn that destroys all skin layers and underlying tissue; characterized by charring or white, leathery appearance of the skin and absence of pain

1. Safety
2. Accident
3. First aid
4. OSHA
5. Cardiac arrest
6. Third-degree burn
7. Second-degree burn
8. Shock
9. Grounded
10. Carelessness
11. First-degree burn
12. Cardiopulmonary resuscitation

Written Test

2. Select true statements concerning things OSHA expects of an employer by placing an "X" next to the true statements.

_______ a. Provide a hazard-free workplace and comply with occupational safety and health standards.

_______ b. Use properly color-coded signs to warn of danger.

_______ c. Report within two weeks to OSHA any accident which is fatal or hospitalizes five or more workers.

_______ d. Obtain a material safety data sheet for each hazardous chemical present in the workplace and make sure the MSDSs are readily accessible to employees.

3. Select true statements concerning things OSHA expects of an employee by placing an "X" next to true statements.

_______ a. Read the OSHA poster #2203 and comply with its standards.

_______ b. Ignore employer safety and health rules.

_______ c. Report to OSHA any hazardous working situations which you feel the employer has not attended to properly.

4. Select true statements concerning basic first aid procedures for emergency situations. Place an "X" in the blanks next to the true statements.

_______ a. Apply antiseptic solution or cream and dress wound with sterile bandages to treat minor bleeding.

_______ b. Chemical burns should be treated by submerging burned area under cold water, then applying a dry, sterile dressing.

_______ c. Some early signs and symptoms of traumatic shock include the following: pale or bluish skin; rapid, weak pulse; vomiting or nausea; and excessive thirst.

_______ d. A victim of traumatic shock should be cooled with a damp cloth to reduce body heat.

_______ e. Do not move a victim or allow a victim to move if a neck or back injury is suspected.

_______ f. A victim who has trouble speaking or breathing, has pale bluish skin, and loses consciousness is suffering from heat exhaustion.

_______ g. In the event of an electrical accident, do not provide any assistance until all electrical current has been shut off.

_______ h. A heat stroke victim should be moved immediately to a cool place.

_______ i. Victims of moderate or severe hypothermia cease shivering.

_______ j. For animal bites, cleanse wound thoroughly with soap and water and apply antiseptic.

Written Test

_______ k. Victims of an allergic reaction to a bee sting should be evacuated to a physician's office or hospital emergency room immediately.

_______ l. Hot and cold compresses, alternated every 3 to 5 minutes, should be applied on coral snake bites.

_______ m. Carefully remove an imbedded tick by grabbing the tick between the thumb and forefinger and pulling quickly straight out.

_______ n. Cold water or ice and a topical antiseptic may be used to treat spider bites.

5. Match the colors of the safety color code on the right with the correct applications.

_______ a. Caution and for marking physical hazards; waste containers for explosive or combustible materials

_______ b. Location of fire fighting equipment; emergency stop switches on machinery

_______ c. Location of first aid equipment

_______ d. Dangerous parts of machines; exposed parts of pulleys, gears, rollers, cutting devices, and power jaws

_______ e. Caution against starting equipment while it is being worked upon

_______ f. Traffic flow; housekeeping practices

_______ g. Radiation hazards

1. Safety green
2. Safety blue
3. Safety orange
4. Safety purple
5. Safety black and/or white
6. Safety red
7. Safety yellow

6. Complete the following statements concerning rules for personal safety by correctly filling in the blanks.

a. Wear _______________ appropriate to the activity being performed.

b. Confine _______________ _______________ before operating equipment.

c. Always wear _______________ _______________ to protect your eyes.

d. Remove all _______________ when working in the shop.

e. Wear ANSI approved _______________ _______________ when working in areas of potential danger of head injuries.

f. Use _______________ and _______________ frequently as a method of preventing skin irritation.

Written Test

7. Select true statements concerning rules for general shop and field safety by placing an "X" in the blanks next to the true statements.

_______ a. Keep all hand tools sharp, clean, and in safe working order.

_______ b. Report all defective tools, machines, or other equipment to supervisor.

_______ c. Retain all guards and safety devices except when procedure is easier without them.

_______ d. Report only accidents with severe injury to the supervisor.

_______ e. Disconnect the power from machine before performing the maintenance task of oiling or cleaning.

_______ f. Operate equipment and machines only when permitted by your supervisor.

_______ g. Distract the attention of a machine operator while working.

_______ h. Turn on switch before checking equipment.

_______ i. Begin trenching and excavating in order to find underground utility lines.

_______ j. Do not work in the dark or in poorly lit areas; use plenty of light.

_______ k. All accidents should be recorded in writing.

8. Complete the following statements concerning characteristics of a clean and orderly shop by correctly filling in the blanks.

a. Machinery and equipment arranged to permit safe, efficient work practices and ease in _______________

b. Materials and supplies safely _______________ or _______________ in proper place

c. Tools and accessories safely stored in cabinets, on _______________ or other suitable devices

d. _______________ _______________ _______ and work benches clear and free of debris and other hazards

e. Floors clean and free from _______________ and slippery substances

f. Aisles, traffic areas, and _______________ free of materials and other debris

g. _______________ materials properly disposed of or stored in approved containers

h. Oily towels stored in approved _______________ containers

i. Sufficient _______________, brushes, and other housekeeping equipment readily available

j. Drinking fountain and _______________ _______________ kept clean and neat at all times

Written Test

9. Match the classes of fire on the right with the correct descriptions.

_______ a. Fires that occur with flammable liquids and gases

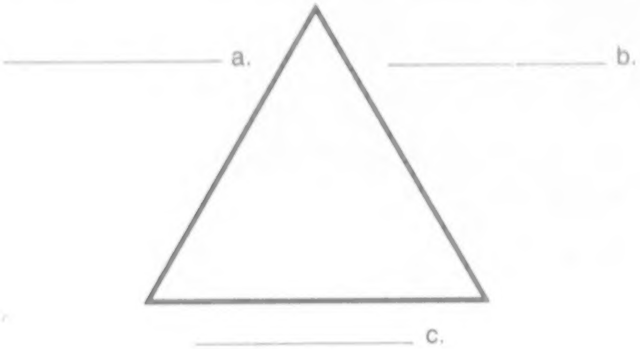
_______ b. Fires that occur in ordinary combustible materials

_______ c. Fires that occur in or near electrical equipment

_______ d. Fires that occur with combustible metals

1. Class A
2. Class B
3. Class C
4. Class D

10. Label the three components of the fire triangle on the following illustration.



11. Match types of fire extinguishers on the right with the classes of fires for which they are designed to extinguish. Answers may be used more than once.

_______ a. Class A

_______ b. Class B

_______ c. Class C

_______ d. Class D

1. Dry chemical
2. Carbon dioxide (CO_2)
3. Foam
4. Pressurized water
5. Halon

Written Test

12. Match fire extinguisher symbols on the right with their meanings. Answers may be used more than once.

_______ a. Class A and B fires but not Class C fires

_______ b. Flammable liquids

_______ c. Class B and C fires but not Class A fires

_______ d. Ordinary combustibles

_______ e. Class A fires but not Class B and C fires

_______ f. Electrical equipment

_______ g. Combustible metals

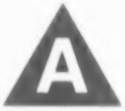
_______ h. Yellow

_______ i. Blue

_______ j. Red

_______ k. Green

1.



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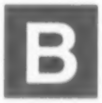

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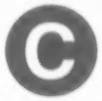

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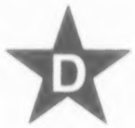

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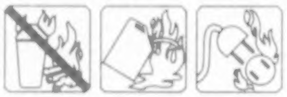

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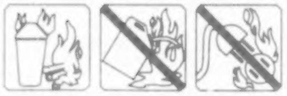

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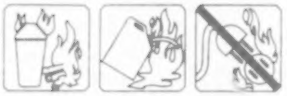


13. Select steps to be followed in case of an accident by placing an "X" in the appropriate blanks.

_______ a. Investigate the accident to determine the cause and to determine ways to prevent the same accident from happening again.

_______ b. Apply a tourniquet in all cases.

_______ c. Administer first aid if needed.

_______ d. Mouth to mouth resuscitation will be administered in all cases.

_______ e. Report all accidents and injuries to the supervisor no matter how minor they may seem.

Written Test

14. Complete statements concerning guidelines for lifting and carrying items safely. Write the correct number on the blank provided before each item.

_____ a. Place your ____________________ as close to the load as possible.

1) head
2) shoulders
3) hip
4) feet

_____ b. Do not ________________ or twist your body to change direction.

1) set the load down
2) turn your head
3) change your grip
4) adjust your footing

_____ c. To set down the load, bend your ________________.

1) arms
2) knees
3) back
4) head

15. Complete statements concerning purposes of a material safety data sheet (MSDS). Write the correct number on the blank provided before each item.

_____ a. To inform ______________ of the material's physical properties or fast-acting health effects that make it dangerous to handle.

1) OSHA
2) the management
3) the user
4) the health department

_____ b. To tell the user the level of ____________________ needed.

1) protective gear
2) medical care
3) hygiene
4) management

_____ c. To tell the user the __________________ necessary if exposed to the product or its hazards.

1) preplanning
2) OSHA regulations
3) legal actions
4) first aid treatment

Written Test

______ d. To tell the management and the user the ____________________ needed for safely handling spills, fires, and day-to-day operations.

1) legal actions
2) preplanning
3) equipment and materials
4) personnel resources

______ e. To tell the user how to ________________________ accidents.

1) report
2) respond to
3) prevent
4) record

Permission to duplicate this test is granted.

General Safety and First Aid
Unit 3-A

Answers to Written Test

1. a. 3
   b. 1
   c. 2
   d. 10
   e. 11
   f. 9
   g. 5
   h. 4
   i. 7
   j. 8
   k. 12
   l. 6

2. a, b, d

3. a, c

4. a, c, e, g, h, j, k, n

5. a. 7
   b. 6
   c. 1
   d. 3
   e. 2
   f. 5
   g. 4

6. a. Clothing
   b. Long hair
   c. Safety glasses
   d. Jewelry
   e. Safety helmet
   f. Soap, water

7. a, b, e, f, j, k

8. a. Cleaning
   b. Sacked, stored
   c. Racks
   d. Working areas
   e. Obstructions
   f. Exits
   g. Combustible
   h. Metal
   i. Brooms
   j. Wash facilities

9. a. 2
   b. 1
   c. 3
   d. 4

10. a. Fuel
    b. Heat
    c. Oxygen

11. a. 1, 3 and 4
    b. 1, 2, 3 and 5
    c. 1, 2 and 5
    d. 1

Answers to Written Test

12.
    a. 7
    b. 2
    c. 5
    d. 1
    e. 6
    f. 3
    g. 4
    h. 4
    i. 3
    j. 2
    k. 1

13. a, c, e

14.
    a. 4
    b. 3
    c. 2

15.
    a. 3
    b. 1
    c. 4
    d. 2
    e. 2

General Safety and First Aid
Unit 3-A

Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Assignment Sheet Ratings

Assignment Sheet 1—Interpret a Material Safety Data Sheet Rating ______

Comments: ______________________

____

Assignment Sheet 2—Analyze Problems Related to Shop Safety and First Aid Rating ______

Comments: ______________________

____

Job Sheet Ratings

Job Sheet 1—Operate a Fire Extinguisher Rating ______

Comments: ______________________

____

Job Sheet 2—Lift a Heavy Object Properly Rating ______

Comments: ______________________

____

Written Test Scores

Pretest ________ Posttest ________ Other ________

Other ______________________

____

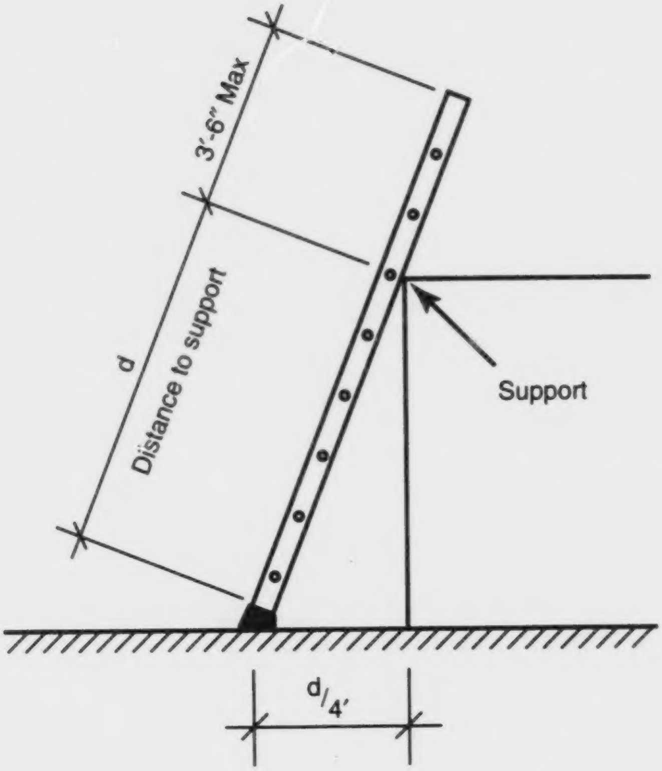
Teacher Signature ______________________ Date ____________

Student Signature ______________________ Date ____________

Permission to duplicate this form is granted.

100

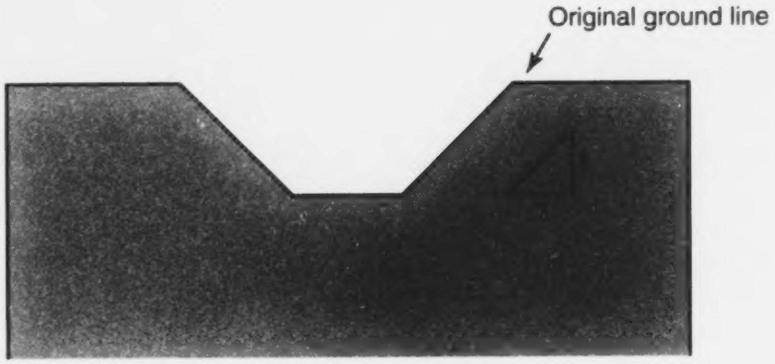
Ladder Safety



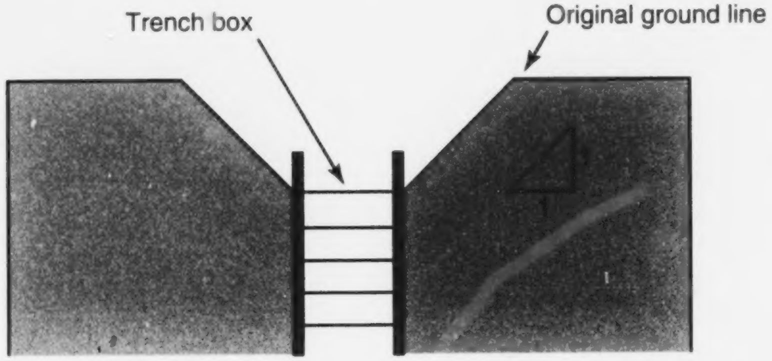
- **Proper placement prevents slipping and tilting**
- **Distance between the bottom of the ladder and the supporting point should be approximately one-fourth of the ladder length between supports**
- **Always face ladder when ascending or descending**
- **Never stand higher than the third rung from top of ladder**
- **Ladders should have nonskid bases**

TM 1

Trench Safety

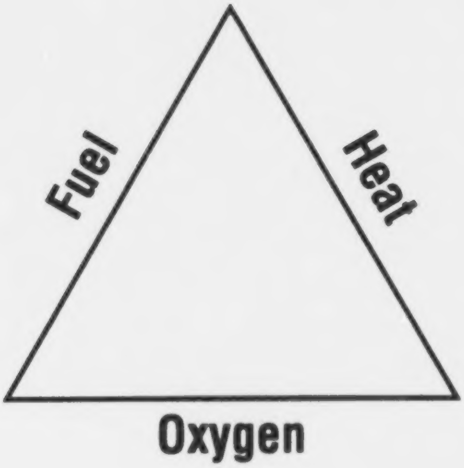


Recommended slope for average soil is 1-1 (45°).
•Soil type should be checked for appropriate angles for slopes.

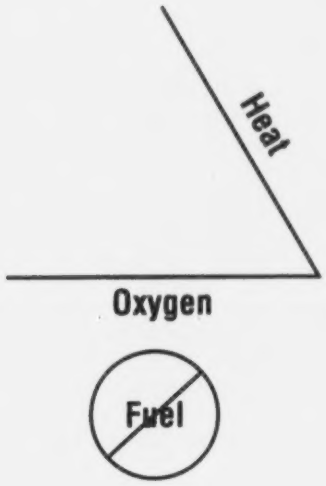


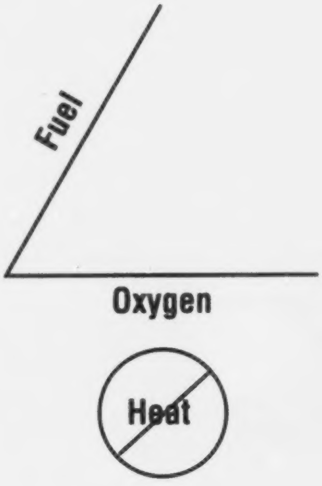
A trench box is used in confined areas.
Always follow OSHA regulations when digging a trench for pipe.

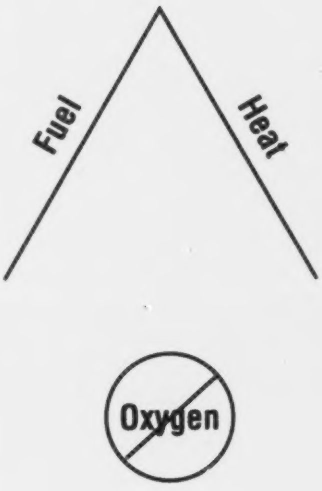
Components of the Fire Triangle



To produce fire, the three elements of the fire triangle must be present at the same time. If any one of the three is missing, a fire cannot be started. With the removal of any one element, the fire will be extinguished.



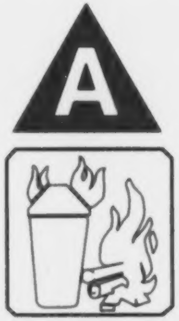




Types of Fire Extinguishers

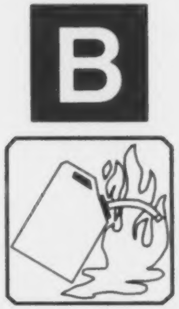
Type of Fire	Approved Type of Extinguisher				
	Pressurized Water	Carbon Dioxide	Multi-Purpose Dry Chemical	Halon Gas	Foam
Class A Fires **ORDINARY COMBUSTIBLES** • Wood • Paper • Cloth, etc.	✓		✓		✓
Class B Fires **FLAMMABLE LIQUIDS, GREASE** • Gasoline • Paints • Oils, etc.		✓	✓	✓	✓
Class C Fires **ELECTRICAL EQUIPMENT** • Motors • Switches, etc.		✓	✓	✓	
Class D Fires **COMBUSTIBLE METALS** • Magnesium • Phosphorus • Iron			✓		

Classes of Fires and Their Fire Extinguisher Symbols



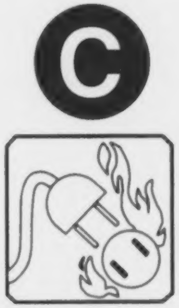
Class A
(Green)

- Ordinary combustibles



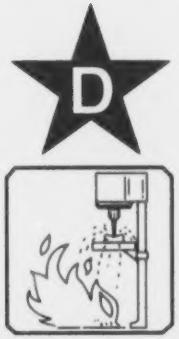
Class B
(Red)

- Flammable liquids and gases



Class C
(Blue)

- Live electrical equipment



Class D
(Yellow)

- Combustible metals

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Teacher Page 29

TM 5

Hand Tools
Unit 1-B

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Hand Tools
Unit 1-B

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resources Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Make transparencies from the transparency masters included in this unit.
- Review "Instructions for Evaluating Student Performance."
- Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

Unit Introduction

- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss the assignment sheets. Review with students the criteria for evaluation of these activities.
- Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and materials are available. Review criteria for evaluation of these activities.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Show the actual tools to the students. **(Listening; and material and facilities)**
- Discuss the cost and quality of hand tools available on the market. **(Listening; speaking; decision making; reasoning; money; and material and facilities)**
- Discuss which tools should be included in every plumber's tool box, and those that might only be used for certain applications such as caulking tools and polybutylene tools. **(Listening; speaking; and decision making)**
- Demonstrate proper handling techniques in reference to safety and convenience. **(Listening; learning how to learn; and technology application)**
- Have trade magazines available for the students who are interested in furthering their knowledge of tools used in plumbing. **(Reading; learning how to learn; and information acquisition and evaluation)**
- Conduct a shop tour of the tool crib/tool storage areas. **(Listening; and material and facilities)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.
- Make copies of the written test. Add or modify test items as needed.
- Give and evaluate written test. Present test in parts to focus on tool identification, use and care, safety, and measuring.
- Compile the assignment sheet ratings, job sheet ratings, and written test scores on the Unit Evaluation Form. Include any additional assignments or supplemental activities that should be part of the unit evaluation.
- Meet individually with students to evaluate their progress through this unit of instruction and indicate to them possible areas of improvement.
- Reteach and retest as required.

Suggested Activities

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

Resources Used in Developing This Unit

- Barclay, Leney. *Residential Plumbing*. Revised by Hank Johnson. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1985.
- Blankenbaker, Keith E. *Modern Plumbing*. South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.

Suggested Supplemental Resources

- *Plumbing Systems: Plumbing Level 1*, Wheels of Learning Series. Englewood Cliffs, NJ: Prentice Hall, 1996.
- Woodson, R.D. *Builder's Guide to Residential Plumbing*. New York: McGraw-Hill, 1996.
- Woodson, R.D. *Plumber's Quick Reference*. New York: McGraw-Hill, 1995.

Hand Tools
Unit 1-B

Answers to Assignment Sheets

Assignment Sheet 1—Read a Rule/Tape Measure

1. 1/2″
2. 3/4″
3. 7/8″
4. 1 1/8″
5. 1 5/16″
6. 1 9/16″
7. 1 3/4″
8. 2″
9. 2 3/16″
10. 2 7/16″
11. 2 5/8″
12. 2 7/8″
13. 3 1/16″
14. 3 1/4″
15. 3 7/16″
16. 3 5/8″
17. 3 7/8″
18. 4″
19. 4 3/16″
20. 4 5/16″

Assignment Sheet 2—Measure Lines to the Nearest Quarter, Eighth, and Sixteenth of an Inch

1. a. 3 1/4″
   b. 4 2/4″ or 1/2″
   c. 3/4″
   d. 2″

2. a. 4 6/8″ or 3/4″
   b. 2 4/8″ or 1/2″
   c. 3 5/8″
   d. 4 1/8″

3. a. 4 1/16″
   b. 1 1/16″
   c. 2 7/16″
   d. 3 1/16″

Hand Tools
Unit 1-B

Written Test

Name ______________________________ Date ____________ Score ____________

1. Match the terms on the right with their correct definitions.

_______ a. Tool used for common plumbing jobs, usually owned by a plumber

_______ b. Tool designed for a particular use, usually provided by the employer

_______ c. Personalized tool kit containing the basic hand tools

_______ d. Tools used to turn threaded pipes and fittings, made in a variety of sizes and shapes

_______ e. Method of developing spiral cuts on pipe in order to facilitate joining

_______ f. Designates joints of pipe in reference to the fitting; female receives the male pipe

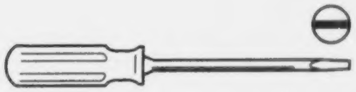
_______ g. A special thread designed for piping systems; does not fit objects with machine threads

_______ h. The state or condition of being free from danger, risk, or injury

1. Threading
2. Male/female
3. Pipe wrenches
4. Plumber's tool box
5. Specialized tool
6. Hand tool
7. Pipe thread
8. Safety

2. Identify the basic hand tools used in the plumbing trade.

a. **Screwdrivers**



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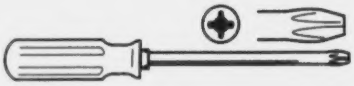

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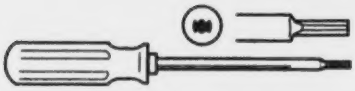

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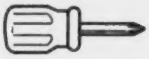

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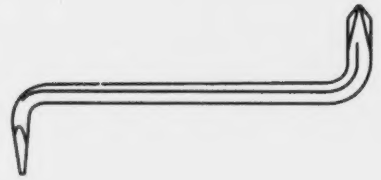

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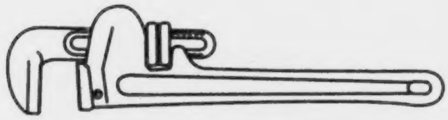
b. **Wrenches**



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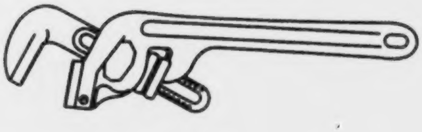

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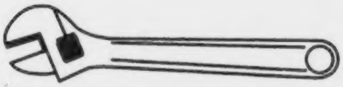

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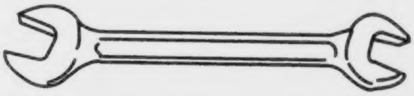

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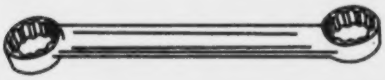

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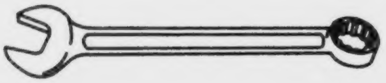

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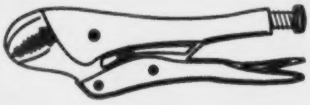

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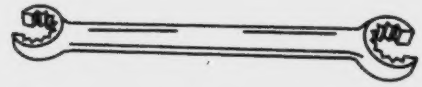

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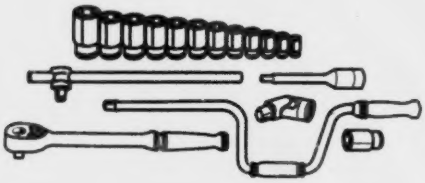

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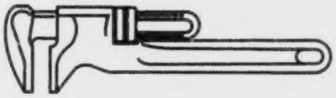

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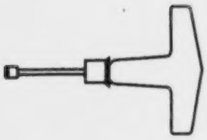

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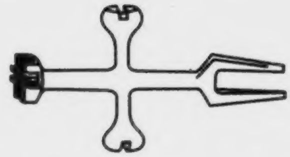

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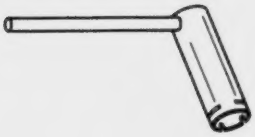

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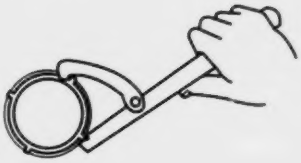

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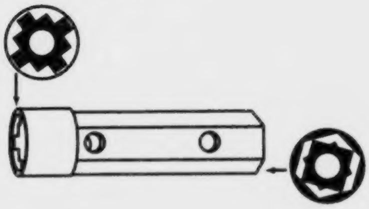

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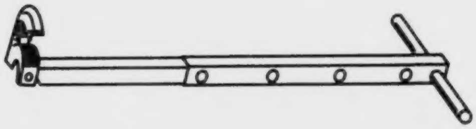

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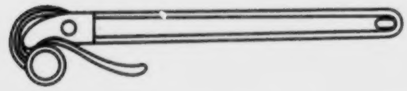

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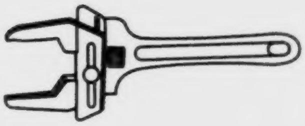

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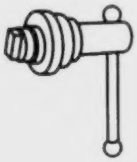
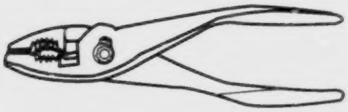


19) ____________________

c. **Pliers**



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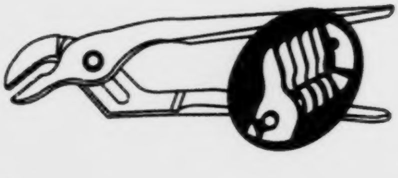

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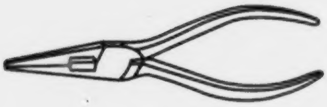

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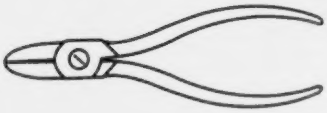

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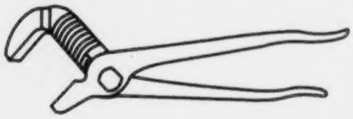

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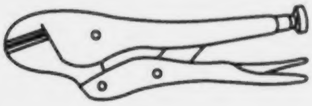
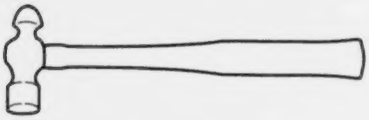


6) ______________________

d. **Hammers and nail pullers**



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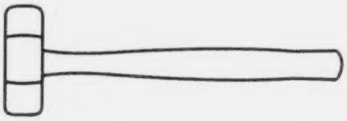

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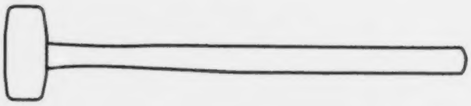

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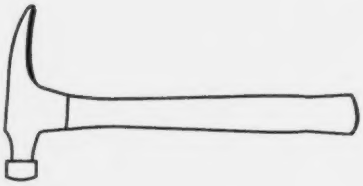

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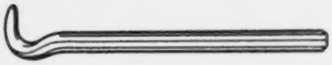

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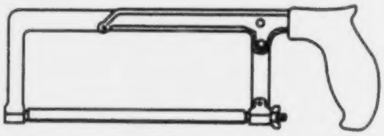
e. **Saws**



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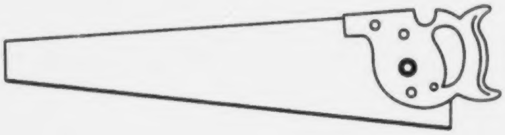

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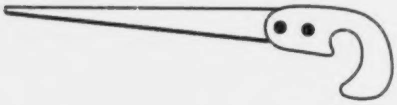

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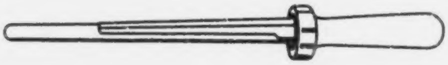

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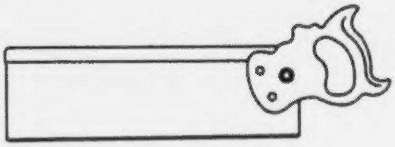
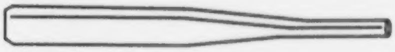


5) ____________________

f. **Punches, chisels, and bars**



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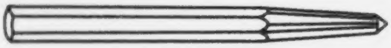

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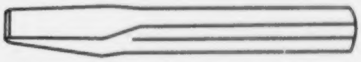

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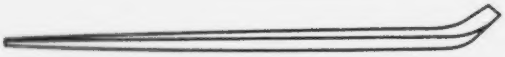

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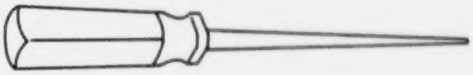

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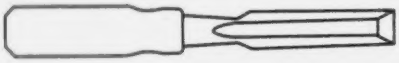

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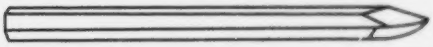

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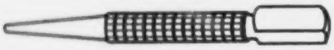
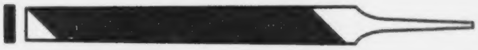


8) ____________________

g. **Files**



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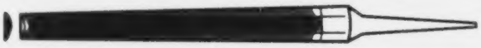

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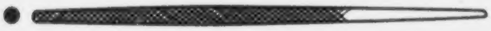

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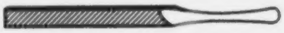

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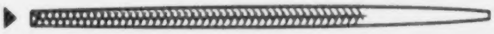

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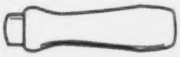
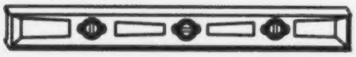
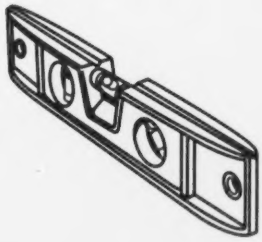


6) ____________________

Written Test

h. **Levels, plumb bob, and chalk line**





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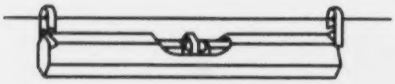
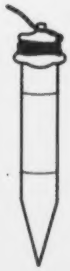
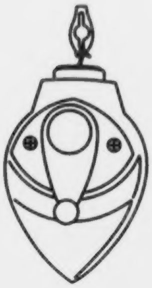


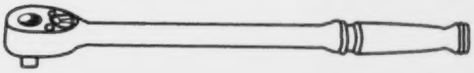


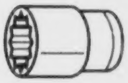
3) ______________________________ 4) ______________________________



5) ______________________________

i. **Socket sets**





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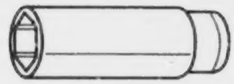
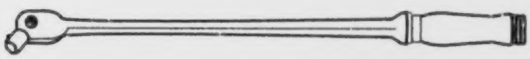
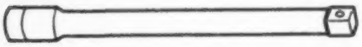




3) ______________________________ 4) ______________________________

Written Test



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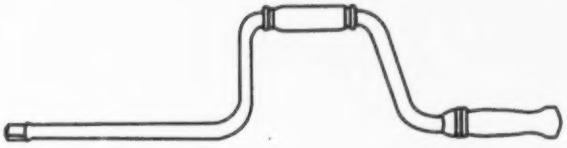
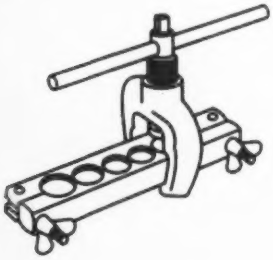


6) ______________________________

j. **Tubing tools**



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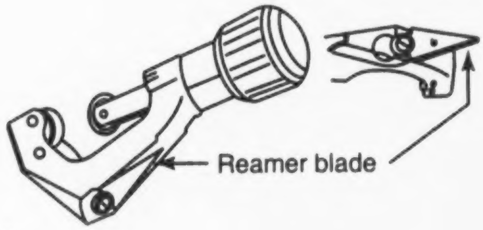

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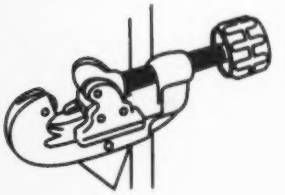

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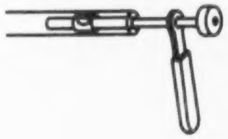

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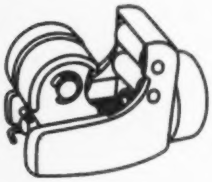

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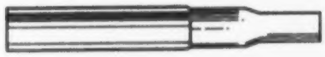

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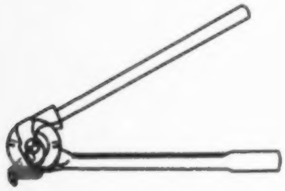

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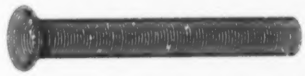

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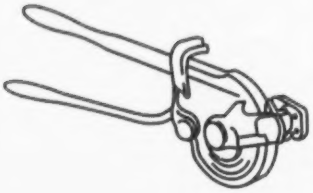
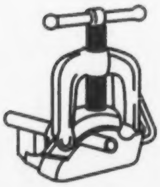
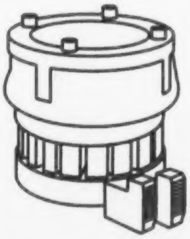


9) ______________________________

k. **Iron pipe tools**





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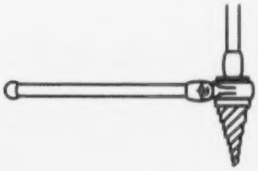
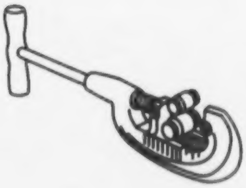
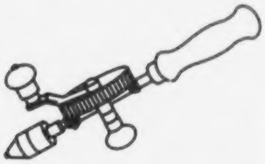


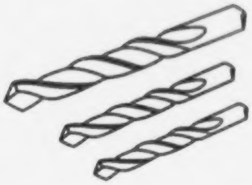


3) ______________________________

4) ______________________________

l. **Drilling and boring tools**





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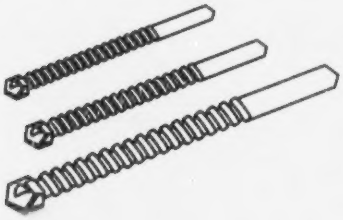
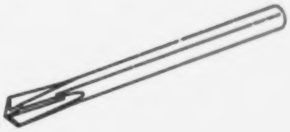


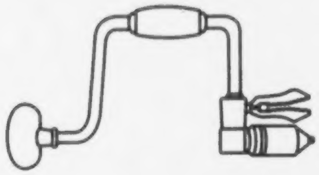


3) ______________________________

4) ______________________________

120

Written Test



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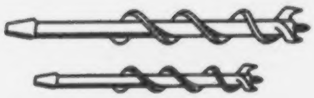

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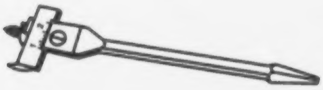
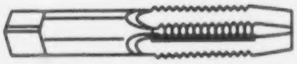


7) ____________________

m. **Threading tools**



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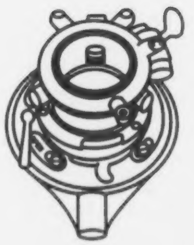

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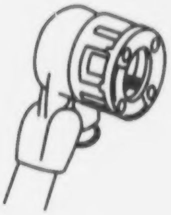

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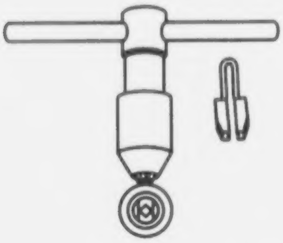

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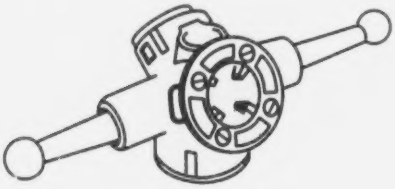
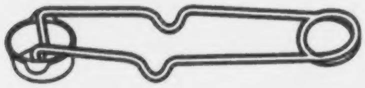


5) ____________________

Written Test

n. Copper tubing tools



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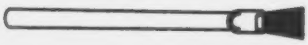

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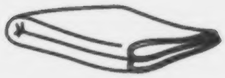

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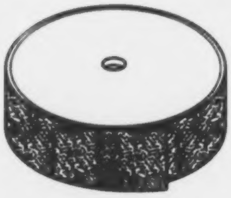

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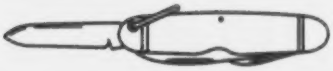

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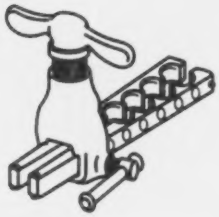

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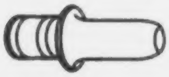

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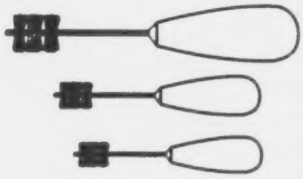
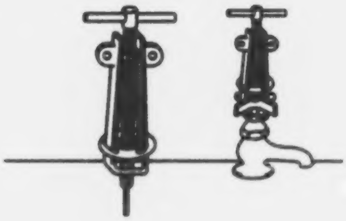


8) ______________________________

o. Faucet and toilet tank repair tools



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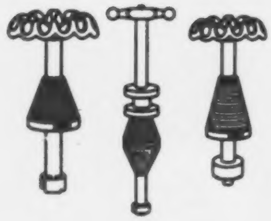

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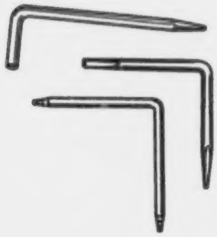

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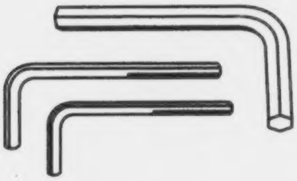

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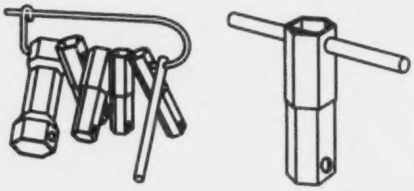

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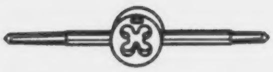
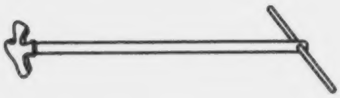
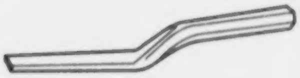


6) ____________________

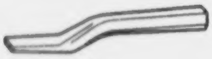


7) ____________________

p. **Caulking tools**



1) ____________________



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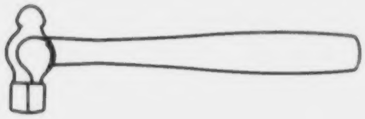

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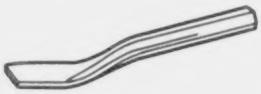

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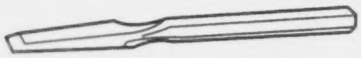
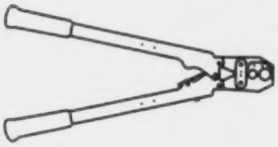


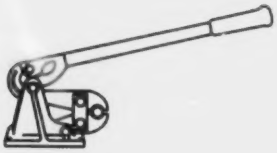
5) ____________________

Written Test

q. Polybutylene tools



1) ______________________________



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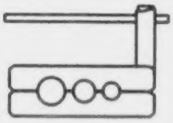

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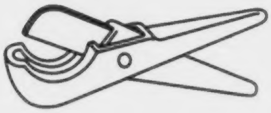

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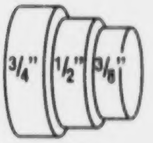

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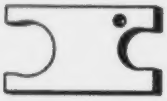

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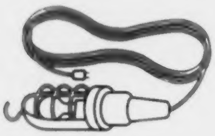
r. Accessory hand tools



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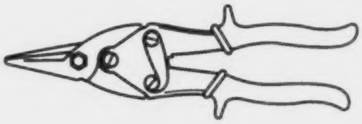

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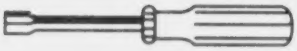

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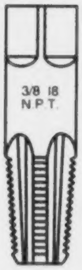
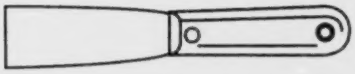


4) ______________________________

Written Test



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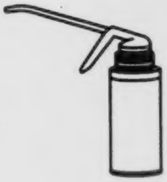
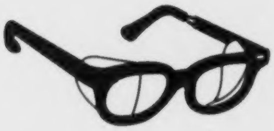
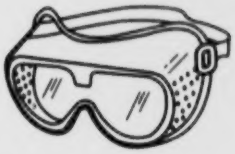


6) ______________________________

s. **Eye protection**



1) ______________________________



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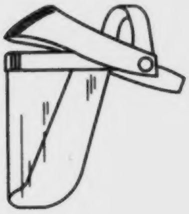


3) ______________________________

3. Complete the following statements concerning the proper use and care of hand tools by circling the correct words.

   a. A **(phillips head, standard slot)** screwdriver is used in fixture installation since most screws on fixture trim have this type head.

   b. An **(offset, adjustable)** pipe wrench is used for working in corners and other tight places.

   c. A **(plug, plier)** pipe wrench has a locking lever to prevent slipping and is used when an especially tight grip is needed.

   d. A **(strap, basin)** wrench is used instead of a pipe wrench when scratches and other pipe wrench damage would affect the appearance of the installation.

   e. **(Needle nose, Slip joint)** pliers are used for retrieving loose parts in a faucet and repairing drop lights and extension cords.

   f. Have plier **(handles, tips)** insulated when working on electrical circuits.

   g. Use a **(nail puller, claw hammer)** to remove nails when destructive methods must be avoided.

Written Test

h. A **(sledge, ball peen)** hammer is used for hammering on metal tools such as punches and chisels.

i. Use a **(handsaw, hacksaw)** for notching access holes and for cutting plastic pipe.

j. A **(jabsaw, keyhole saw)** is used for cutting curved shapes in close quarters.

k. Most saws cut on the **(backward, forward)** stroke.

l. Number of teeth per inch indicates **(the quality of the saw, how fine a cut the saw will make)**.

m. A **(center, pin)** punch is used for making indentations in metal for starting a drill.

n. Use a **(flat, bullnose)** chisel for cutting off bolt heads or splitting nuts.

o. A **(scratch awl, nail set)** is used in various ways such as chipping glazed bathroom tile for screw holes when hanging lavatories.

p. Wood chisels should be ground to a **(25, 45)** degree angle and must periodically be honed and oiled in order to maintain a sharp edge.

q. Rasps are wood files used to **(enlarge pipe holes, file contact points)**.

r. Use **(short quick, long slow)** strokes when filing.

s. Release pressure on the **(forward, back)** stroke when using a file as the cutting edges can be worn down by applying too much pressure.

t. A **(level, plumb bob)** is used to locate the center of vertical runs and to transfer the point from one floor level to another.

u. A **(speed, hinge)** handle is used with sockets when more force is needed to break loose or tighten a nut or bolt.

v. Do not use an extension pipe or cheater bar on the handle of a **(socket, ratchet)** as too much force will strip the gears in the mechanism.

w. A **(flaring tool, swage punch)** is used to enlarge the end of a tube so that another tube of the same size may be placed in it and soldered.

x. Use a **(pipe reamer, pipe vise)** to hold pipe for cutting or threading.

y. A **(masonry, star)** drill is used for drilling bathroom tile and in making holes in concrete for anchor bolts.

z. Use a **(die stock, t-handle tap wrench)** to hold taps and dies during the threading process.

aa. A **(swaging, hammer flaring)** tool saves the expense of fittings by enlarging tubing ends to act as couplings.

bb. Valve seat **(dressers, wrenches)** are used to remove worn surfaces and burrs from valve seats.

Written Test

cc. Keep cutting edges on valve seat dressers clean and **(free from oil, lightly oiled)**.

dd. A **(crimp caliper, tool set gauge)** is used to make inside and outside measurements of pipes or objects.

ee. Straight snips are used for cutting **(tubing, vent pipe)**.

ff. **(Safety glasses, Goggles)** protect eyes from dust, flying particles, and splashed liquids.

4. List six safety precautions for handling and storing hand tools.

   a. ____________________

   b. ____________________

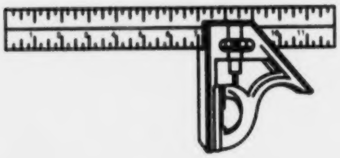
   c. ____________________

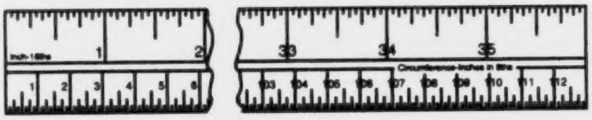
   d. ____________________

   e. ____________________

   f. ____________________

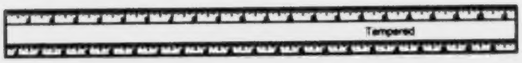
5. Identify rules used for measuring.

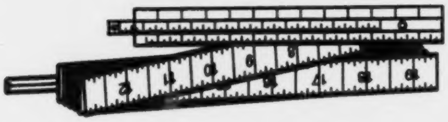




a. ____________________

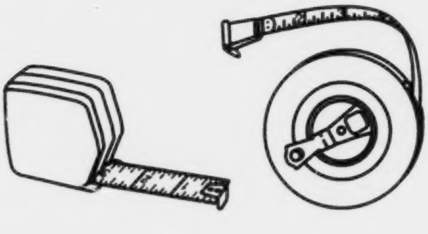
b. ____________________





c. ____________________

d. ____________________



e. ____________________

Written Test

6. Select true statements concerning guidelines for the use and care of rules and steel tapes by placing an "X" in the appropriate blanks.

______ a. Use the proper length and graduation.

______ b. Use finest graduation for accuracy.

______ c. Any quality ruler is acceptable.

______ d. Never bend or distort a steel rule.

______ e. Use rules only for their intended purpose.

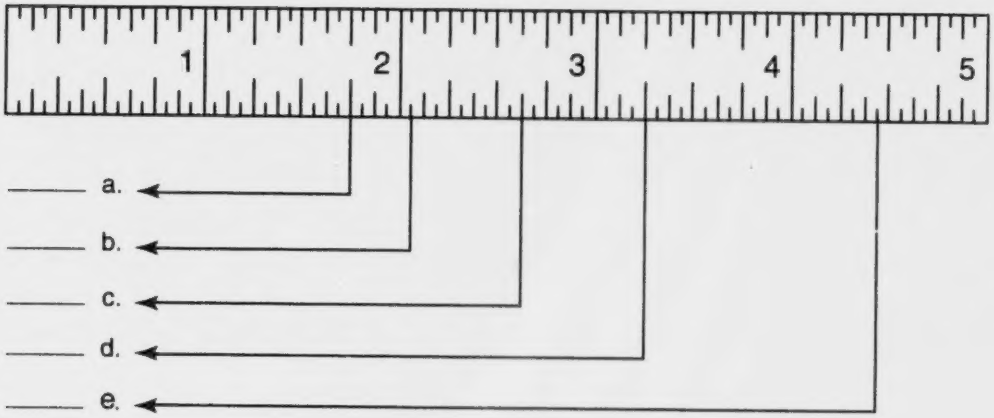
______ f. Rewind steel tapes quickly.

______ g. Use rule on edge for accurate reading.

______ h. Apply a generous amount of oil to the joints of a folding rule in order to lessen wear.

______ i. Keep steel tapes clean and free from oil.

7. Read the following rule and place the correct dimension for each arrow on the corresponding line.



______ a.

______ b.

______ c.

______ d.

______ e.

Permission to duplicate this test is granted.

Hand Tools
Unit 1-B

Answers to Written Test

1. a. 6
   b. 5
   c. 4
   d. 3
   e. 1
   f. 2
   g. 7
   h. 8

2. a. Screwdrivers
   1) Standard slot
   2) Phillips
   3) Clutch head
   4) Stubby
   5) Offset

   b. Wrenches
   1) Straight pipe
   2) Offset pipe
   3) Adjustable
   4) Open end
   5) Box end
   6) Combination
   7) Plier (vise grips)
   8) Flare nut
   9) Socket and ratchet
   10) Spud
   11) No-hub torque
   12) Plug
   13) Sink strainer
   14) Strainer locknut
   15) Closet seat
   16) Basin
   17) Strap
   18) All-purpose
   19) Internal

   c. Pliers
   1) Slip joint
   2) Slip groove
   3) Needle nose
   4) Diagonal cutter
   5) Adjustable
   6) Pinch-off

   d. Hammers and nail pullers
   1) Ball peen
   2) Soft face
   3) Long-handle sledge
   4) Straight claw
   5) Nail puller

   e. Saws
   1) Hacksaw
   2) Handsaw
   3) Compass or keyhole
   4) Jabsaw
   5) Miter

Answers to Written Test

f. Punches, chisels, and bars
   1) Pin punch
   2) Center punch
   3) Cold chisel
   4) Pry bar
   5) Scratch awl
   6) Wood chisel
   7) Bullnose chisel
   8) Nail set

g. Files
   1) Flat
   2) Half round
   3) Round (rattail)
   4) Point
   5) Triangular
   6) Handle

h. Levels, plumb bob, and chalk line
   1) Carpenter's level
   2) Torpedo level
   3) Line level
   4) Plumb bob
   5) Chalk line

i. Socket sets
   1) Ratchet handle
   2) Socket
   3) Deep socket
   4) Hinge handle (break-over)
   5) Extension
   6) Speed handle

j. Tubing tools
   1) Flaring tool
   2) Tubing reamer
   3) Tubing cutter
   4) Internal cutter
   5) Close tubing cutter
   6) Swage punch
   7) Lever-type bender
   8) Spring bender
   9) Geared ratchet-type bender

k. Iron pipe tools
   1) Pipe vise
   2) Dies and die head
   3) Pipe reamer
   4) Pipe cutter

Answers to Written Test

l. Drilling and boring tools
  1) Hand drilling machine
  2) High speed drill bits
  3) Masonry drilling bits
  4) Star drill bit
  5) Ratchet brace
  6) Wood bits
  7) Expansive wood bit

m. Threading tools
  1) Tap
  2) Stock and dies
  3) Die stock
  4) T-handle tap wrench
  5) Three-way pipe die

n. Copper tubing tools
  1) Striker
  2) Flux brush
  3) Clean towel/wiping cloth
  4) Sand cloth
  5) Pocket knife
  6) Yoke and screw flaring tool
  7) Hammer flaring tool
  8) Copper fitting brushes

o. Faucet and toilet tank repair tools
  1) Faucet handle puller
  2) Valve seat dresser
  3) Valve seat wrench
  4) Hex wrench (allen wrench)
  5) Plumber's socket wrench
  6) Tubing tap and die set
  7) Sink spray wrench

p. Caulking tools
  1) Yarning iron
  2) Inside or outside caulking iron
  3) Caulking hammer
  4) Packing iron
  5) Cut-off chisel

q. Polybutylene tools
  1) Handheld crimping tool
  2) Bench-mounted crimping tool
  3) Universal crimping tool
  4) Polybutylene tubing cutter
  5) Tool set gauge
  6) Crimp calipers

Answers to Written Test

r. Accessory hand tools
    1) Drop light
    2) Straight snips
    3) Nut driver
    4) Pipe tap
    5) Putty knife
    6) Cutting or lubricating oil

s. Eye protection
    1) Safety glasses
    2) Goggles
    3) Face shield

3. a. Phillips head
    b. Offset
    c. Plier
    d. Strap
    e. Needle nose
    f. Handles
    g. Nail puller
    h. Ball peen
    i. Handsaw
    j. Keyhole saw
    k. Forward
    l. How fine a cut the saw will make
    m. Center
    n. Flat
    o. Nail set
    p. 25
    q. Enlarge pipe holes
    r. Long slow
    s. Back
    t. Plumb bob
    u. Hinge
    v. Ratchet
    w. Swage punch
    x. Pipe vise
    y. Masonry
    z. T-handle tap wrench
    aa. Swaging
    bb. Dressers
    cc. Lightly oiled
    dd. Crimp caliper
    ee. Vent pipe
    ff. Goggles

4. Any six of the following:
    a. Store tools in proper location to prevent damage to tools or possible injury to worker.
    b. Provide ample room to work; remove any objects that may get in the way.
    c. Carry to the work area only those tools that you will need.
    d. Use two or more people to move large pieces of equipment and heavy boxes.
    e. Lay out your tools in an orderly fashion.
    f. Hand tools to co-workers; never throw them.
    g. Wear gloves for protection against heat and flying debris.
    h. Wear eye and face protection to prevent injury from splattering liquids or flying debris.
    i. Avoid carrying sharp instruments such as screwdrivers in pockets where ends will protrude.
    j. Keep such items as gas hoses and electric cords neat and orderly and not in a tangled mess.
    k. Keep electric cords away from water.
    l. Wash hands after handling tools and before eating.

5. a. Combination square
    b. Circumference rule
    c. Steel rule
    d. Folding rule
    e. Steel tape

6. a, b, d, e, g

Answers to Written Test

7. a. 1 3/4″
   b. 2 1/16″
   c. 2 5/8″
   d. 3 1/4″
   e. 4 7/16″

Hand Tools
Unit 1-B

Unit Evaluation Form

Student Name ______________________________ Unit Rating ______________

Assignment Sheet Ratings

Assignment Sheet 1—Read a Rule/Tape Measure Rating ________

Comments: ____

____

Assignment Sheet 2—Measure Lines to the Nearest Quarter, Eighth, and Sixteenth of an Inch Rating ________

Comments: ____

____

Job Sheet Ratings

Job Sheet 1—Use Hand Tools to Inspect/Replace a Washer on a Globe Valve Rating ________

Comments: ____

____

Job Sheet 2—Measure and Mark a Predetermined Length of Pipe Rating ________

Comments: ____

____

Job Sheet 3—Use Hand Tools to Cut a Length of Steel Pipe Rating ________

Comments: ____

____

Job Sheet 4—Use Hand Tools to Ream Steel Pipe Rating ________

Comments: ____

____

Unit Evaluation Form

Job Sheet 5—Use Hand Tools to Cut Pipe Threads Rating ________

Comments: ____

____

Job Sheet 6—Set Up and Use a Hacksaw to Cut a Length of PVC Pipe Rating ________

Comments: ____

____

Written Test Scores

Pretest ________ Posttest ________ Other ________

Other ____

____

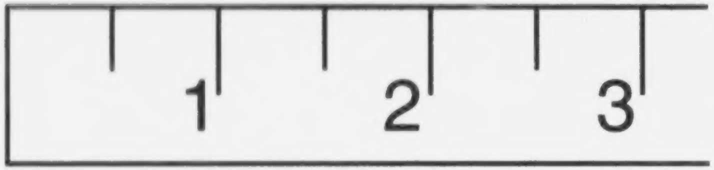
Teacher Signature ____________________ Date ____________

Student Signature ____________________ Date ____________

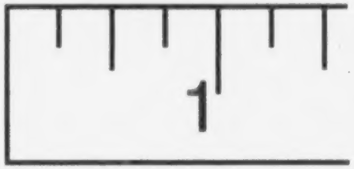
Permission to duplicate this form is granted.

Graduations on a Rule

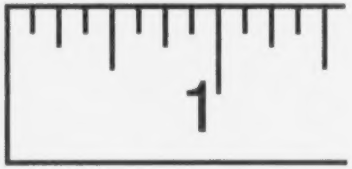
Halves



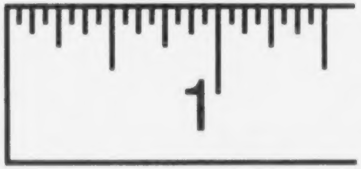
Quarters

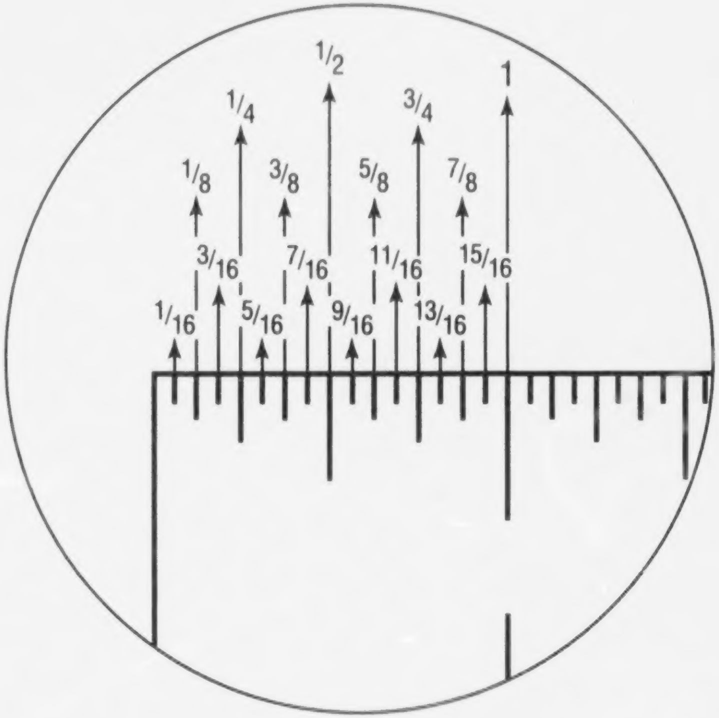


Eighths



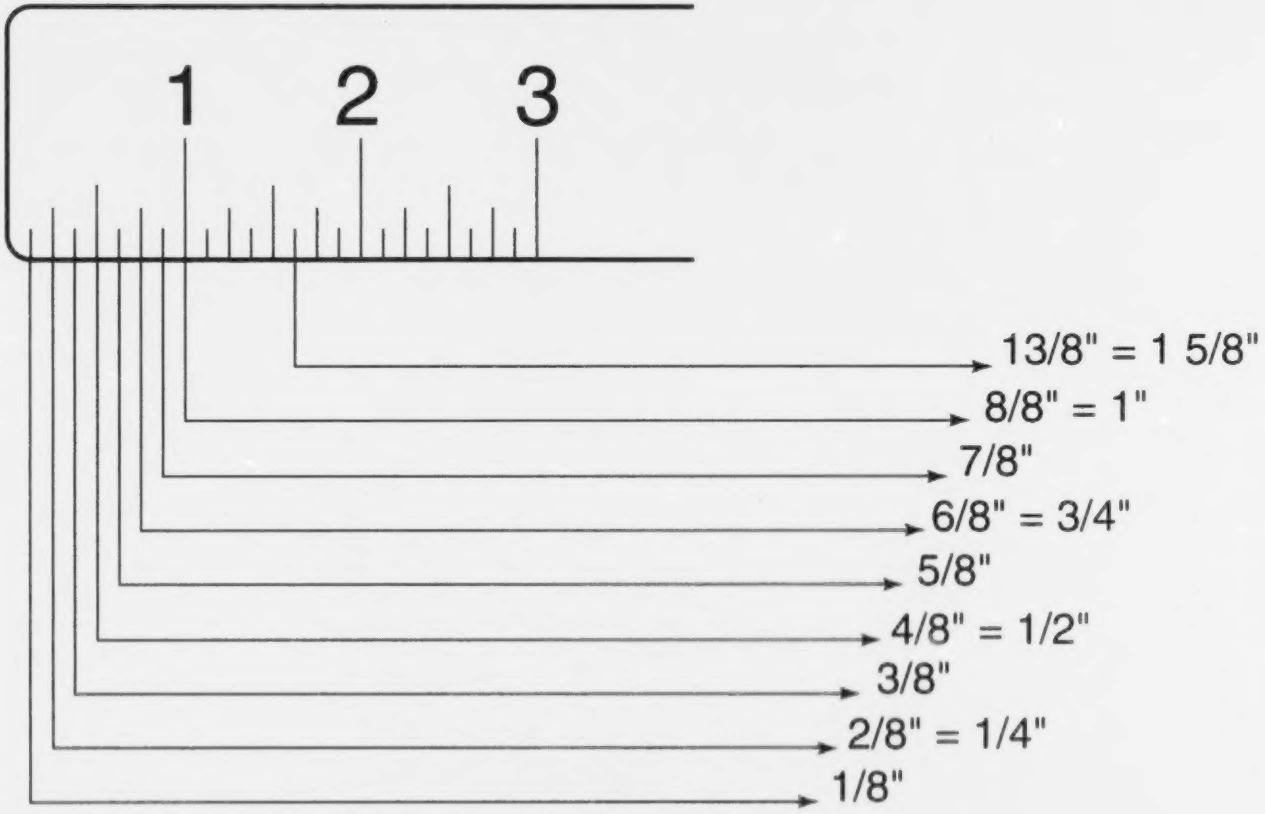
Sixteenths



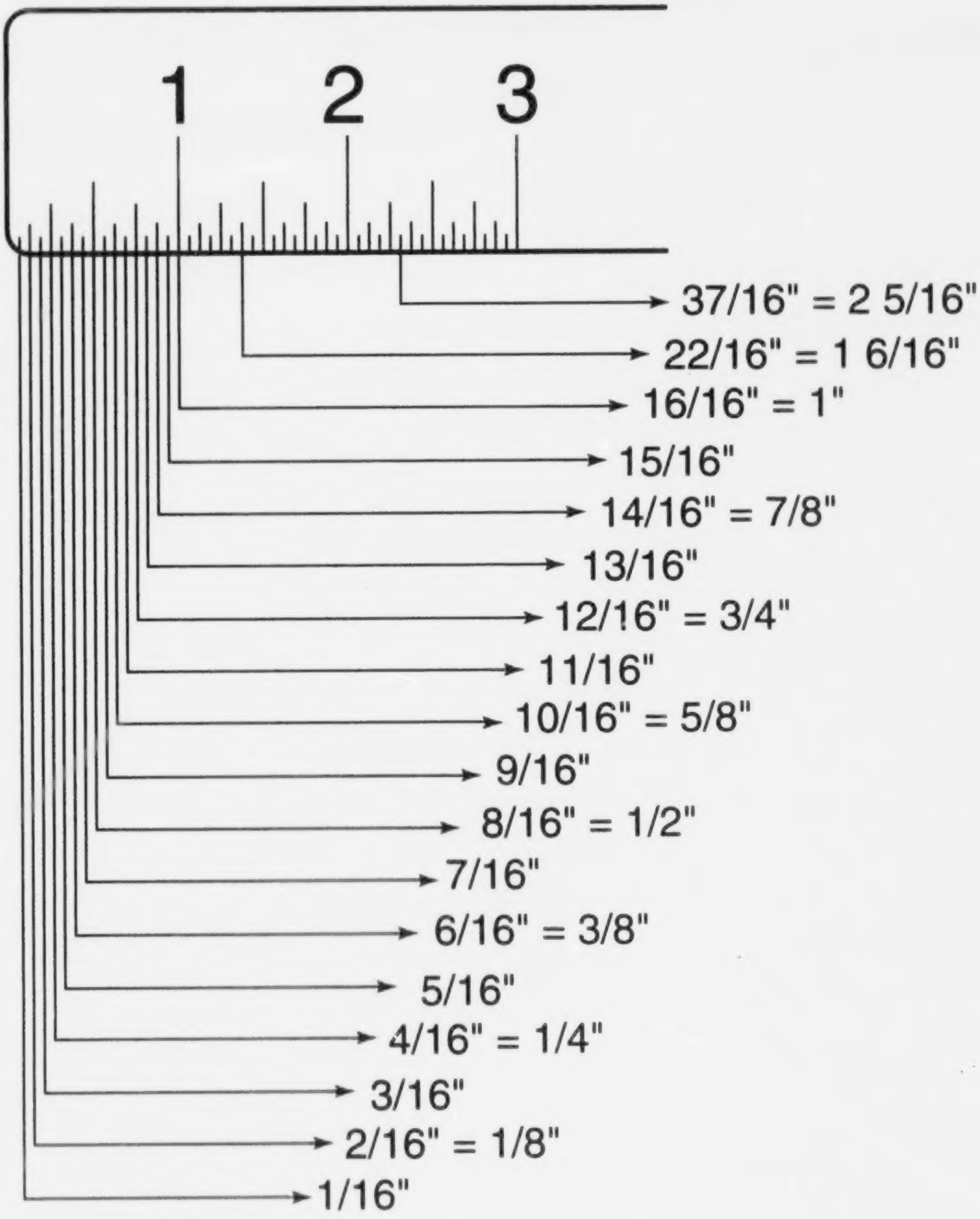


Graduations Applied to a Rule

Reading the Eighths Rule



Reading the Sixteenths Rule



Power Tools
Unit 2-B

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Suggested Activities 3
Written Test 7
Answers to Written Test 11
Unit Evaluation Form 15

Student Components **Page**

Objective Sheet B-53
Information Sheet B-55
Job Sheets
  1—Install a Lavatory Hanger on a Concrete Wall B-63
  2—Cut Out a Bathtub Drain Opening in a Plywood Floor B-67
  3—Thread Steel Pipe With a Portable Power-Driven Vise Stand B-71

Power Tools
Unit 2-B

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resources Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Review "Instructions for Evaluating Student Performance."
- Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

Unit Introduction

- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and materials are available. Review criteria for evaluation of these activities.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Show students the power tools available in the shop. **(Listening; and material and facilities)**
- Compare cost and quality of power tools on the market with the class. **(Listening; decision making; reasoning; money; and material and facilities)**
- Have students look up tools in catalogs to get an idea of the cost involved in equipping a shop. **(Reading; decision making; reasoning; money; and material and facilities)**
- Demonstrate proper use and care of power tools to the class. **(Listening; learning how to learn; and technology application)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.
- Make copies of the written test. Add or modify test items as needed.
- Give and evaluate written test.
- Compile the job sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignments or supplemental activities that should be part of the unit evaluation.
- Meet individually with students to evaluate their progress through this unit of instruction and indicate to them possible areas of improvement.
- Reteach and retest as required.

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Suggested Activities

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

Resources Used in Developing This Unit

- Barclay, Leney. *Residential Plumbing.* Revised by Hank Johnson. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1985.
- Blankenbaker, Keith E. *Modern Plumbing.* South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.

Suggested Supplemental Resources

- Davidson, Homer L. *Trouble Shooting and Repairing Power Tools.* Blue Ridge Summit, PA: TAB Books, 1990.
- *Plumbing Systems: Plumbing Level 1*, Wheels of Learning Series. Englewood Cliffs, NJ: Prentice Hall, 1996.
- Woodson, R.D. *Builder's Guide to Residential Plumbing.* New York: McGraw-Hill, 1996.
- Woodson, R.D. *Plumber's Quick Reference.* New York: McGraw-Hill, 1995.

Power Tools
Unit 2-B

Written Test

Name ______________________ Date __________ Score __________

1. Match terms on the right with the correct definitions.

_____ a. Tools which are operated with electricity, air, or gasoline

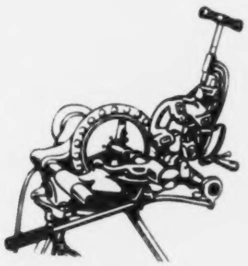
_____ b. Tools, both hand and power, used to install the initial stage of the building's plumbing, including cutting and drilling access holes and connecting piping

_____ c. Moving in a back and forth motion, as opposed to a circular motion

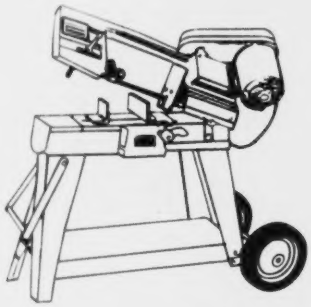
_____ d. Cutting and grinding of material by a thin wheel made of a hard, stone-like substance

1. Reciprocating
2. Power tools
3. Abrasive
4. Roughing-in tools

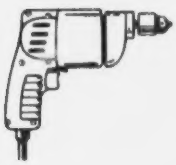
2. Identify power tools used in the plumbing trade.



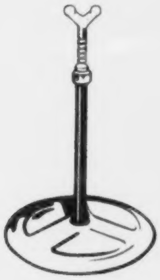
a. ______________________



b. ______________________



c. ______________________



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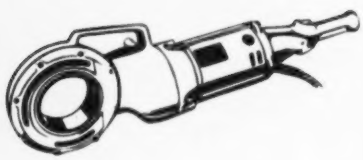

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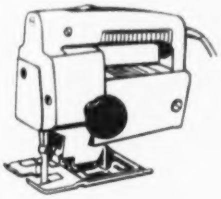

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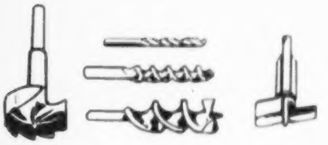

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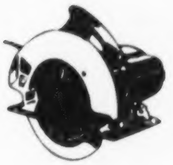

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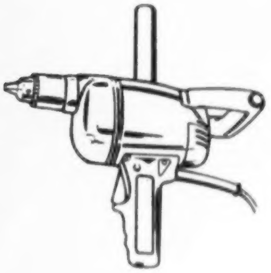

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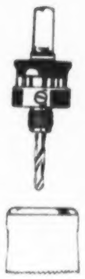

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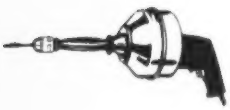

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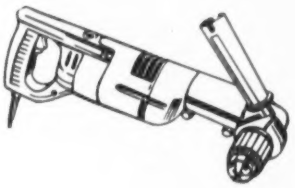

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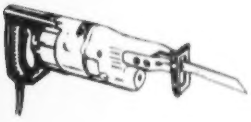

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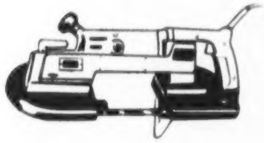

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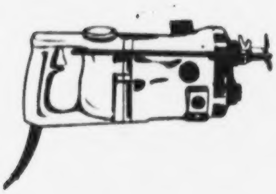

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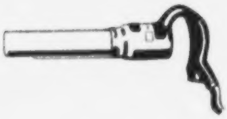

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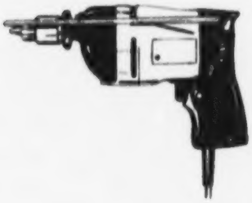

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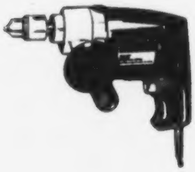

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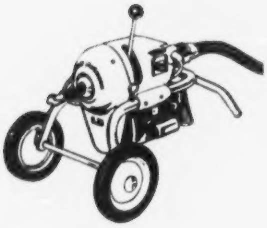

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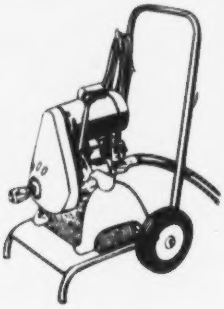


t.

3. Discuss the use and care of power tools used in the plumbing trade.

   a. Drilling machines

   b. Saws

c. Concrete tools

____

____

____

____

d. Threading machines

____

____

____

____

e. Sewer and drain cleaning equipment

____

____

____

____

4. List ten safety precautions for power tools used in plumbing.

a. ____

b. ____

c. ____

d. ____

e. ____

f. ____

g. ____

h. ____

i. ____

j. ____

Permission to duplicate this test is granted.

Power Tools
Unit 2-B

Answers to Written Test

1. a. 2
   b. 4
   c. 1
   d. 3

2. a. Portable electric pipe threader
   b. Bench band saw
   c. $^{1}/_{4}$″ electric drill
   d. Pipe support
   e. Portable power drive
   f. Saber saw
   g. Assortment of wood bits
   h. Circular saw
   i. $^{1}/_{2}$″ straight electric drill
   j. Hole saw
   k. Electric snake
   l. $^{1}/_{2}$″ angle electric drill
   m. Portable electric saw
   n. Portable band saw
   o. Electric rotary hammer
   p. Air hammer
   q. $^{3}/_{8}$″ hammer drill
   r. Electric chipping hammer
   s. Electric power drain cleaner
   t. Compressed air or gasoline power drain cleaner

3. Discussion should include:
   a. Drilling machines
      - Small drills ($^{1}/_{4}$″) develop more RPMs than large drills because the larger units are designed to turn larger cutting tools or to drill in heavy materials, and both of these factors require a slower speed.
      - The chuck key should be strapped to the power cord.
      - The cutting tool must be kept sharp in order to avoid forcing the machine and causing unnecessary wear and short life.
      - Drilling machines should be kept in the storage box when not in use in order to avoid damage.
   b. Saws
      - Saw blades should be kept sharp in order to avoid excessive forcing of the machine.
      - Portable electric circular saws are used for cutting lumber, but can be fitted with abrasive wheels to cut metal and concrete.
      - Power saws should be operated at a limited speed of cut in order to avoid blade breakage.
      - Reciprocating power saws are often used for cutting irregular shaped pipe holes and openings, especially in difficult to reach place.
      - Small reciprocating power saws (saber saws) are helpful in cutting out countertops for kitchen sinks.
      - Hole saws cut holes in wood or metal.

Answers to Written Test

c. Concrete tools
  - Used for cutting into and through concrete
  - Hammer drills make holes in concrete by "hammering" the rotating bit.
  - Air hammers are used to break up large sections of concrete and to make large holes.
  - Circular saws (abrasive wheels) are used to cut openings for pipes in concrete walls, floors, and ceilings.

d. Threading machines
  - Used for cutting threads to save time and energy
  - Especially helpful on large jobs where a great deal of thread cutting is required.
  - Threading machines are necessary for cutting threads on pipe larger than 2".
  - Threading machines usually cut, ream, and thread pipe.

e. Sewer and drain cleaning equipment
  - Handheld drain cleaning machines are used to clean out obstructions in waste pipes.
  - Power sewer cleaners are designed to clean out soil and sewer pipes with powerful motors and long, strong cables.

4. Any ten of the following:

a. Know the tool you are using, its application, limitations, and potential hazards.

b. Select proper tool for the job.
  - Don't try to tackle a big job with an undersized tool.
  - Makeshift tools can cause accidents.

c. Ground all tools unless double insulated.
  - Three-prong plug should be plugged into a three-hole electrical receptacle.
  - If an adapter is used to accommodate two-prong receptacles, the adapter wire must be attached to a known ground.

d. Remove adjusting keys and wrenches before turning on tool.

e. Keep work area free of clutter.

f. Keep guards in place and in working order.
  - Do not remove.
  - Do not wedge out of the way.

g. Always be alert to potential hazards in your working environment.
  - Be very cautious of damp locations when working with electricity.
  - Be aware of the presence of highly combustible materials such as gasoline and naphtha.

h. Avoid accidental startup.
  - Make sure switch is off before plugging in cord.
  - Turn power switch off when power is interrupted.

i. Make sure saw blades, drill bits, and cutters are sharp, clean, and regularly maintained.

j. Use only accessories recommended by the manufacturer.

k. Do not force tool.

l. Wear safety glasses.

m. Do not overreach.

n. Never leave power tool running unattended.
  - Don't leave until it comes to a complete stop.
  - Don't leave until it is disconnected from power source.
  - Don't remove drill or bit until machine has stopped running.

o. Don't surprise or touch anyone operating a power tool.

p. Never adjust or change bits, blades, or cutters with tool connected to power.

q. Dress properly.
  - Avoid loose clothing that could catch in moving parts.
  - Wear rubber boots in damp locations.
  - Gloves can be caught by revolving machinery.

Answers to Written Test

r. Secure work.
s. Do not use tool with frayed cord.
t. Never brush away chips or sawdust while tool is operating.
u. Do not attempt field repairs.
v. Store tools in dry, secure location where they won't be tampered with or stolen.

Power Tools
Unit 2-B

Unit Evaluation Form

Student Name ______________________________ Unit Rating ____________

Job Sheet Ratings

Job Sheet 1—Install a Lavatory Hanger on a Concrete Wall Rating ______

Comments: ____

____

Job Sheet 2—Cut Out a Bathtub Drain Opening in a Plywood Floor Rating ______

Comments: ____

____

Job Sheet 3—Thread Steel Pipe With a Portable Power-Driven Vise Stand Rating ______

Comments: ____

____

Written Test Scores

Pretest ________ Posttest ________ Other ________

Other ____

____

Teacher Signature ______________________________ Date ____________

Student Signature ______________________________ Date ____________

Permission to duplicate this form is granted.

Equipment
Unit 3-B

Unit Contents

Teacher Components **Page**

Suggested Activities 3
Written Test 7
Answers to Written Test 17
Unit Evaluation Form 19

Student Components **Page**

Objective Sheet B-73
Information Sheet B-75
Job Sheets
  1—Light and Adjust the Air-Acetylene Torch B-87
  2—Set Up and Adjust the Builder's Level B-89
  3—Set Up an Inflatable Rubber Test Plug in a Pipe B-95
  4—Set Up a Mechanical Test Plug in a Pipe B-97
  5—Set Up and Operate a Ratchet Lever Hoist B-99

Equipment
Unit 3-B

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resources Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Review "Instructions for Evaluating Student Performance."
- Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

Unit Introduction

- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and materials are available. Review criteria for evaluation of these activities.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Show students the equipment available in the shop. **(Listening; and selection)**
- Discuss safety precautions that must be followed when working with gas and gas equipment. **(Listening; speaking; and application)**
- Discuss the various uses for air-acetylene and air-propane torches. **(Listening; speaking; selection; and application)**
- Demonstrate the procedure for tying acceptable knots when using ropes and slings. **(Listening; learning how to learn; and technology application)**
- Explain the importance of an organized plumbing truck. **(Listening; reasoning; and material and facilities)**
- Conduct an inventory of a typical plumbing truck. **(Listening; reasoning; and material and facilities)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.
- Make copies of the written test. Add or modify test items as needed.
- Give and evaluate written test.
- Compile the job sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignments or supplemental activities that should be part of the unit evaluation.
- Meet individually with students to evaluate their progress through this unit of instruction and indicate to them possible areas of improvement.
- Reteach and retest as required.

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Suggested Activities

- Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

Resources Used in Developing This Unit

- Barclay, Leney. *Residential Plumbing*. Revised by Hank Johnson. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1985.
- Blankenbaker, Keith E. *Modern Plumbing*. South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.

Suggested Supplemental Resources

- *Plumbing Systems: Plumbing Level 1*, Wheels of Learning Series. Englewood Cliffs, NJ: Prentice Hall, 1996.
- Woodson, R.D. *Builder's Guide to Residential Plumbing*. New York: McGraw-Hill, 1996.
- Woodson, R.D. *Plumber's Quick Reference*. New York: McGraw-Hill, 1995.

Equipment
Unit 3-B

Written Test

Name ________________________ Date ____________ Score ____________

1. Match the terms on the right with the correct definitions.

________ a. A heavy, flammable, gaseous, paraffin hydrocarbon found in crude petroleum and natural gas which is used as a fuel

________ b. Tool used to create a controlled flame which is used for soldering copper fittings

________ c. A colorless, gaseous hydrocarbon made by the action of water on calcium carbide which is used as a fuel

________ d. Isolating a piping system with plugs of various types and applying air pressure, water, smoke, or other agents in order to check for leaks in the system

________ e. Instrument used to lift heavy objects with the least amount of strain on the worker

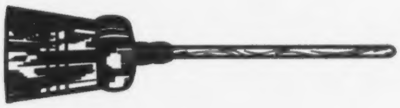
________ f. Instruments used to determine grade when installing long lengths of pipe

________ g. Excavation made for the installation of pipe

________ h. Electric powered grinding wheel used to sharpen tools and wear away excess metal from various objects

1. Bench grinder
2. Test
3. Hoist
4. Trench
5. Torch
6. Propane
7. Acetylene
8. Optical instruments

2. Identify equipment generally used in plumbing.



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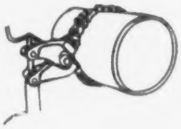

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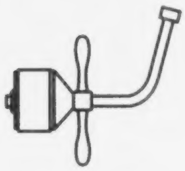

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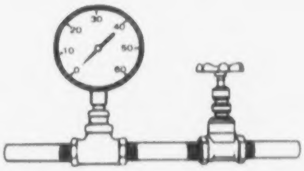

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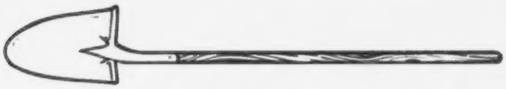
Written Test



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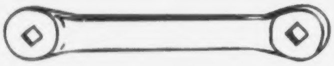

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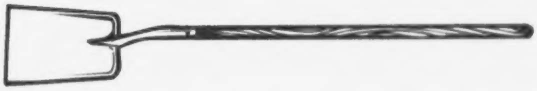

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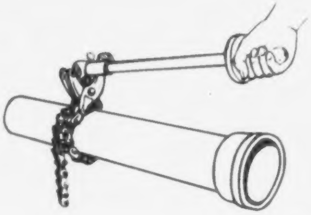

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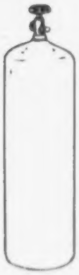

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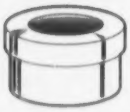

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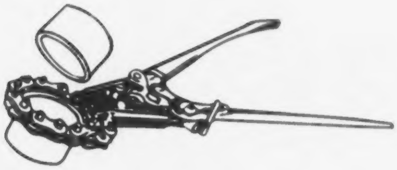

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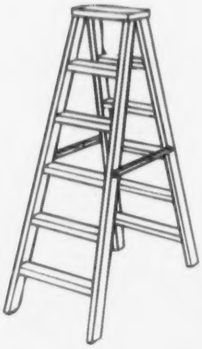

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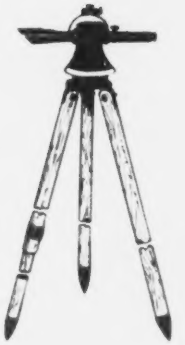
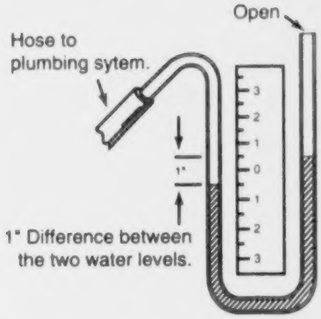
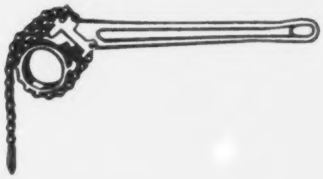
Written Test

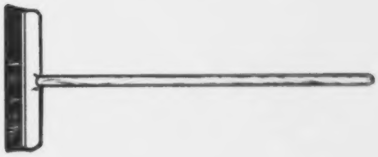



Open
Hose to plumbing sytem.
1"
1" Difference between the two water levels.
3
2
1
0
1
2
3

m. ______________________

n. ______________________





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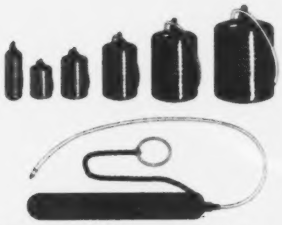

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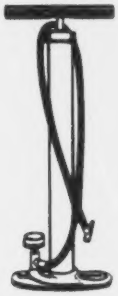

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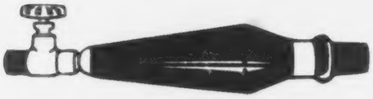

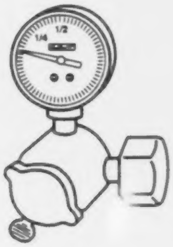

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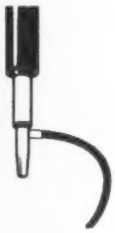
Written Test



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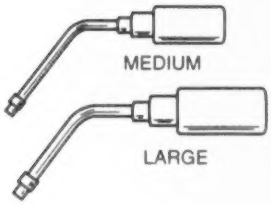
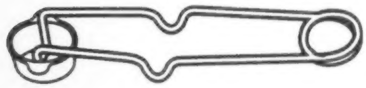


v. ______________________________



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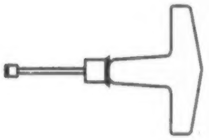
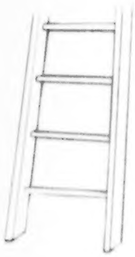
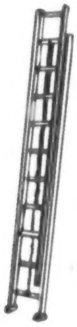


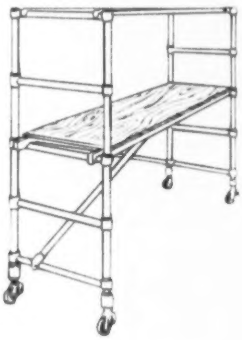
x. ______________________________



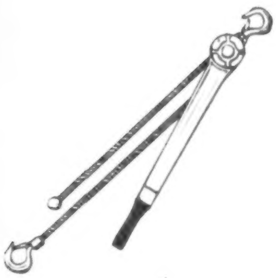
y. ____________________



z. ____________________



aa. ____________________



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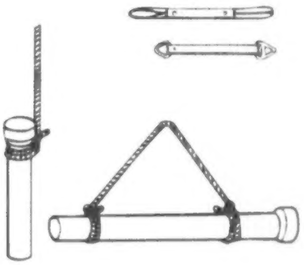
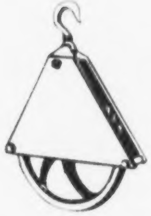
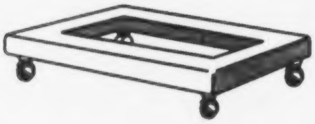


cc. ______________________________

Written Test





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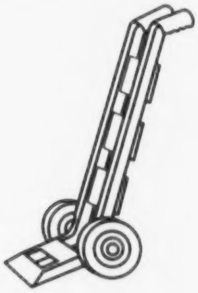

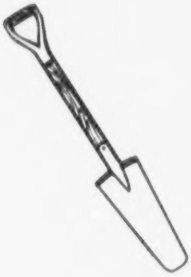

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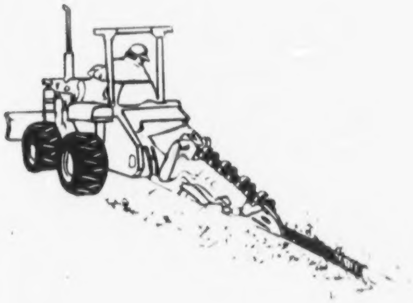
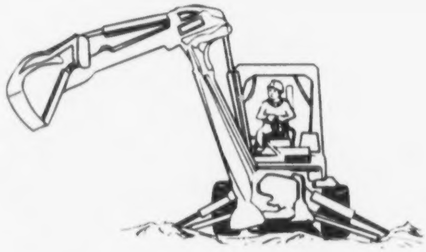
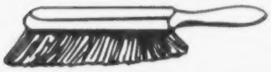
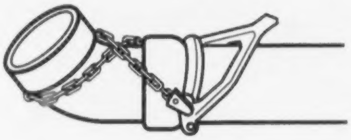




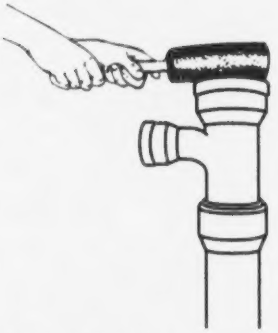
hh. ______________________________ ii. ______________________________



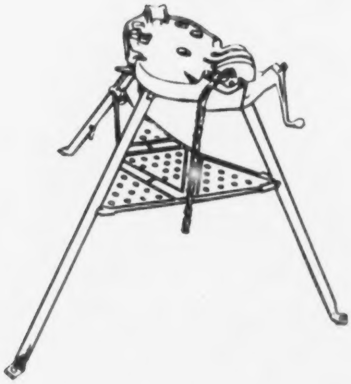


jj. ______________________________ kk. ______________________________

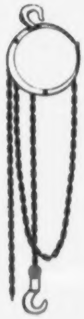
Written Test

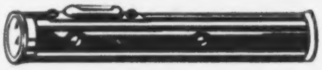


Courtesy of Tyler Pipe Company

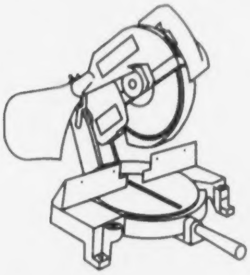


ll. ______________________________ mm. ______________________________





nn. ______________________________ oo. ______________________________



pp. ______________________________

Written Test

3. Match the types of equipment on the right with their correct use or care statement. Write the corresponding number in the blank provided. Types of equipment and use or care statements continue on the next page.

________ a. Used to seal a drainage system or part of a drainage system to check for leaks

________ b. Used to heat copper tube and melt solder to make sweat joints

________ c. Used for working short distances above ordinary reach level

________ d. Used to reach the roof of single-story buildings

________ e. Used to reach the roof of two-story buildings

________ f. Used to raise or lower heavy objects or to hold them temporarily in position

________ g. Used to lift or pull heavy loads for short distances

________ h. Can transport heavy objects along level surfaces and slight grades

________ i. Can transport heavy objects over rough ground, up and down stairs, up and down steep grades, and over level surfaces

________ j. Used for general digging purposes

________ k. Used to make tunnels under sidewalks, shrubs, driveways, or porches

________ l. Used for cutting straight lines in grass sod, squaring corners of excavations, and helping to make tunnels under sidewalks, shrubs, driveways, or porches

________ m. Used to dig narrow and comparatively shallow trenches

________ n. Used to dig wide (average 18″–24″) and deep (average 8′–10′) trenches

1. Lead hammer
2. Torch
3. Dolly
4. Ratchet lever hoist
5. Test caps
6. Manometer
7. Power trencher
8. Extension ladder
9. Stepladder
10. Hand levels
11. Backhoe
12. Sharp shooter shovel
13. Ropes and slings
14. Assembly tools
15. Square point shovel
16. Scaffolds
17. Round point shovel
18. Test gauge assembly

Written Test

_______ o. Used to install fittings

_______ p. Used to pull cast iron pipes and fittings together

_______ q. Used by the residential plumber primarily to determine pitch of long runs of pipe

_______ r. Help make lifting easier and help prevent strains and bruises

_______ s. Permit light and medium weight objects to be lifted considerable distances with savings of time and energy

_______ t. Used to inflate rubber test plugs after they are inserted in the piping system

_______ u. Used to attach the air pump to the piping system being tested and to show amount of pressure on a gauge

_______ v. Usually provided by bricklayers, plasterers, and/or painters and are sometimes used by plumbers to reach high places in a building

_______ w. Useful for making rough measurements of trench depths

_______ x. Device used to measure the amount of pressure developed in a piping system being tested

_______ y. Used to seal the ends of pipes in order to seal the system for a test

19. Tire pump
20. Builder's level
21. Hand truck
22. Single ladder
23. Hand chain hoist
24. Gin block
25. Mechanical test plug

4. List two safety precautions related to operating an air-acetylene torch outfit for each part of the air-acetylene torch outfit.

   a. Regulator

      1) ______________________________

      2) ______________________________

   b. Gauges

      1) ______________________________

      2) ______________________________

   c. Hoses

      1) ______________________________

      2) ______________________________

d. Torches

1) ______________________________

2) ______________________________

e. Torch tips

1) ______________________________

2) ______________________________

Permission to duplicate this test is granted.

Equipment
Unit 3-B

Answers to Written Test

1.
   a. 6
   b. 5
   c. 7
   d. 2
   e. 3
   f. 8
   g. 4
   h. 1

2.
   a. Hand broom
   b. Hydraulic pipe cutter
   c. Mechanical test plug
   d. Test gauge assembly
   e. Round point shovel
   f. Cylinder wrench (air-acetylene torch outfit)
   g. Square point shovel
   h. Ratchet pipe cutter
   i. "B" acetylene tank
   j. Test cap
   k. Squeeze type pipe cutter
   l. Stepladder
   m. Builder's level
   n. Manometer
   o. Heavy duty chain wrench
   p. Push broom
   q. Inflatable rubber test plug
   r. Tire pump
   s. Torch handle (air-acetylene torch outfit)
   t. Regulator (air-acetylene torch outfit)
   u. Halide torch leak detector
   v. Tips (air-acetylene torch outfit)
   w. Striker
   x. Tank key
   y. Single ladder
   z. Extension ladder
   aa. Scaffolding
   bb. Ratchet lever hoist
   cc. Ropes and slings
   dd. Gin block
   ee. Dolly
   ff. Hand truck
   gg. Sharp shooter shovel
   hh. Power trencher
   ii. Backhoe
   jj. Bench brush
   kk. Pipe puller
   ll. Lead hammer
   mm. Vise stand
   nn. Hand chain hoist
   oo. Hand level
   pp. Circular miter saw

3.
   a. 25
   b. 2
   c. 9
   d. 22
   e. 8
   f. 23
   g. 4
   h. 3
   i. 21
   j. 17
   k. 12
   l. 15
   m. 7
   n. 11
   o. 1
   p. 14
   q. 20
   r. 13
   s. 24
   t. 19
   u. 18
   v. 16
   w. 10
   x. 6
   y. 5

4. Any two safety precautions for each of the following sections:
   a. Regulator
      - Keep regulator off when not in use.
      - Be sure to turn adjustment screw completely off prior to start up.
      - Inspect all nuts and connections prior to using the regulators.
      - Do not force connections of hoses and regulators.
      - Use the proper regulator on the proper cylinder.
      - Do not exceed recommended pressures.
      - Have only skilled mechanics repair faulty regulators.

Answers to Written Test

b. Gauges
  - Keep glass protected from breaking.
  - Replace any broken gauge glasses.
  - Do not attempt to repair a defective gauge.

c. Hoses
  - Test hoses for leaks by immersing in water at normal working pressure.
  - Use only one type of gas in the hose.
  - Avoid dragging the hose on a greasy floor.
  - Avoid circumstances where a hose can be rolled upon, kinked, burned, or subjected to falling objects or hot metals.
  - Keep hose connections tight.
  - Do not repair a hose with tape.
  - Keep the hose properly rolled and stored when not in use.

d. Torches
  - Keep all connections to the torch tight.
  - Any torch suspected of being faulty should be repaired by a competent service person.
  - Avoid any contact with greasy or oily substances.

e. Torch tips
  - Do not remove a tip from the torch when it is hot.
  - Use the manufacturer's wrench to remove the torch tip.
  - Handle tips carefully.

Equipment
Unit 3-B

Unit Evaluation Form

Student Name ______________________________ Unit Rating ____________

Job Sheet Ratings

Job Sheet 1—Light and Adjust the Air-Acetylene Torch Rating ______

Comments: ____

____

Job Sheet 2—Set Up and Adjust the Builder's Level Rating ______

Comments: ____

____

Job Sheet 3—Set Up an Inflatable Rubber Test Plug in a Pipe Rating ______

Comments: ____

____

Job Sheet 4—Set Up a Mechanical Test Plug in a Pipe Rating ______

Comments: ____

____

Job Sheet 5—Set Up and Operate a Ratchet Lever Hoist Rating ______

Comments: ____

____

Written Test Scores

Pretest ________ Posttest ________ Other ________

Other ____

____

Unit Evaluation Form

Teacher Signature ______________________ Date ______________

Student Signature ______________________ Date ______________

Permission to duplicate this form is granted.

Blueprint Reading
Unit 1-C

Unit Contents

Teacher Components **Page**

Suggested Activities 3
Answers to Assignment Sheets 7
Written Test 9
Answers to Written Test 19
Unit Evaluation Form 23
Transparency Master 1—Alphabet of Lines 25

Student Components **Page**

Objective Sheet C-1
Information Sheet C-3
Student Supplements
  1—Plot Plan C-25
  2—Foundation Plan C-27
  3—Floor Plan C-29
  4—Elevation Plan C-31
  5—Elevation Plan (Continued) C-33
  6—Section Drawing C-35
  7—Details (Cornice and Window) C-37
  8—Details (Foundations and Fireplace) C-39
  9—Details (Kitchen, Bathrooms, and Other) C-41
  10—Schedules C-43
Assignment Sheets
  1—Read the Architect's Scale at 1/4" = 1' C-45
  2—Read the Architect's Scale at 1/8" = 1' C-47
  3—Read the Architect's Scale at 1" = 20' C-49
  4—Read the Architect's Scale at 1" = 50' C-51
  5—Determine Dimensions on a Drawing Using an Architect's Scale C-53

Blueprint Reading
Unit 1-C

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resources Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Make transparency from the transparency master included in this unit.
- Obtain architect's scales for students to use with assignment sheets and plan presentation.
- Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

Unit Introduction

- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Refer students to supplements to view examples of architectural drawings. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss the assignment sheets. Review with students the criteria for evaluation of these activities.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Invite an inspector and/or architect to speak to the class about reading blueprints. **(Reading; listening; seeing things in the mind's eye; and interpretation)**
- Provide an actual set of residential blueprints for the students to read. **(Reading; seeing things in the mind's eye; and interpretation)**
- Compare a set of residential blueprints to a set of blueprints for a commercial building. Discuss the differences with the class. **(Reading; listening; speaking; seeing things in the mind's eye; and interpretation)**
- Discuss which section in a set of blueprints usually includes a plumbing drawing. **(Reading; listening; speaking; seeing things in the mind's eye; and acquisition and evaluation)**
- Discuss the parts of a set of blueprints that are most important to a plumber. **(Reading; listening; speaking; seeing things in the mind's eye; and acquisition and evaluation)**
- Provide architect's scales for the students to use in Assignment Sheet 5. **(Mathematics; and reasoning)**
- Discuss how to read and use an architect's scale and explain which scales are most commonly used. **(Mathematics; reasoning; selection; and application)**
- Compare an architect's scale to an engineer's scale. **(Mathematics; reasoning; selection; and application)**
- Compare a set of computer generated blueprints and a set of hand drawn blueprints. Discuss the differences with the class. **(Reading; listening; seeing things in the mind's eye; reasoning; and selection)**
- Demonstrate how to determine the type, quality, and quantity of plumbing fixtures required by an actual set of residential specifications and plans. **(Reading; listening; seeing things in the mind's eye; reasoning; and interpretation)**
- Demonstrate how to determine the type of pipe and fittings required by an actual set of residential specifications and plans. **(Reading; listening; seeing things in the mind's eye; reasoning; and interpretation)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.
- Make copies of the written test. Add or modify test items as needed.
- Give and evaluate written test.

Suggested Activities

- Compile the assignment sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignments or supplemental activities that should be part of the unit evaluation.
- Meet individually with students to evaluate their progress through this unit of instruction and indicate to them possible areas of improvement.
- Reteach and retest as required.

Resources Used in Developing This Unit

- Barclay, Leney. *Residential Plumbing*. Revised by Hank Johnson. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1985.
- Blankenbaker, Keith E. *Modern Plumbing*. South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.

Blueprint Reading
Unit 1-C

Answers to Assignment Sheets

Assignment Sheet 1—Read the Architect's Scale at 1/4″ = 1′

1. 1′
2. 7′-6″
3. 8′-6″
4. 14′
5. 19′
6. 24′

Assignment Sheet 2—Read the Architect's Scale at 1/8″ = 1′

1. 1′
2. 4′-6″
3. 17′-6″
4. 20′
5. 32′
6. 40′

Assignment Sheet 3—Read the Architect's Scale at 1″ = 20′

1. 20′
2. 35′
3. 50′
4. 65′
5. 100′
6. 120′

Assignment Sheet 4—Read the Architect's Scale at 1″ = 50′

1. 12′-6″
2. 25′
3. 37′-6″
4. 50′
5. 100′
6. 162′-6″
7. 225′
8. 300′

Answers to Assignment Sheets

Assignment Sheet 5—Determine Dimensions on a Drawing Using an Architect's Scale

Note: Students' answers may vary slightly from these due to variations in printing.

1. 51′-2″
2. 27′-1″
3. 6′-10″
4. 17′-3″
5. 21′-7″
6. 29′-7″
7. 4′-1″
8. 16′-5″
9. 11′-4″
10. 8′-0″
11. 16′-0″
12. 35′-4″
13. 13′-11″
14. 9′-5″
15. 16′-8″
16. 4′-1″
17. 12′-7″
18. 15′-9″
19. 2′-9″
20. 14′-6″
21. 56′-8″
22. 16′-0″
23. 13′-11″

Blueprint Reading
Unit 1-C

Written Test

Name ______________________________ Date ____________ Score ____________

1. Match the terms on the right with the correct definitions. Definitions continue on the next page.

_______ a. A drawing of an object that has been cut to show internal construction

_______ b. A technical drawing which includes all dimensions and procedures to guide workers in the construction of a building

_______ c. A detailed set of written instructions which explains the drawing and the materials used, and becomes part of the legal contract

_______ d. An arbitrary sign that has been standardized and is used to represent an object, quality, or method

_______ e. Collection of laws listed in booklet form that apply to a given community, state, or nation

_______ f. Step-by-step directions which are shown graphically

_______ g. A drawing that gives complete detailed information for the construction of part of an object

_______ h. Set of conventional symbols covering all the lines needed to depict an object as to size and shape

_______ i. The arrangement of lines and symbols to indicate the actual size for constructing the object that is represented

_______ j. Horizontal cut through a building showing the foundation, rooms, partitions, windows, doors, and stairs

_______ k. A rule divided into proportional feet and inches; a fraction of an inch is proportionally equal to one foot

_______ l. Angle of roof designed to drain rain water; also adds to beauty of building

1. Alphabet of lines
2. Architect's scale
3. Architectural drawings
4. Blueprint
5. Building code
6. Detail view
7. Dimensions
8. Roof pitch
9. Plan view
10. Scale drawing
11. Section view
12. Specifications
13. Symbol
14. Working drawing
15. Elevation view

_____ m. Drawings representing the front, sides, or rear face of a building or object; usually made as though the observer were looking straight at it

_____ n. A copy of the original detailed architectural or construction drawing

_____ o. A drawing made to size either proportionally larger or smaller than the actual size of the object represented

2. List four types of architectural drawings.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

3. Match lines from the alphabet of lines on the right with their correct names.

_____ a. Break line

_____ b. Cutting-plane line

_____ c. Section line

_____ d. Center line

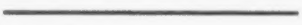
_____ e. Hidden line

_____ f. Object line

_____ g. Leader

_____ h. Dimension line

_____ i. Extension line

1.


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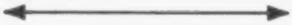

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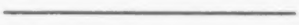

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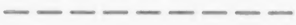

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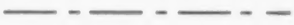

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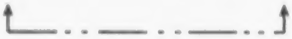

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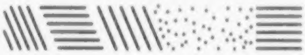

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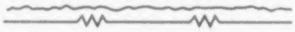

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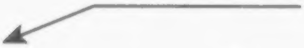
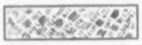
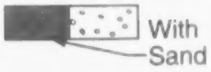


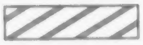
Written Test

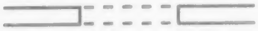
4. Match floor plan and section drawing names on the right with their correct symbols.

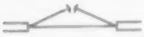
- Floor plan and section symbols

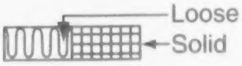
______ a. 

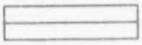
______ b. 

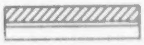
______ c. 

______ d. 

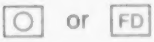
______ e. 

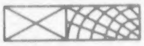
______ f. 

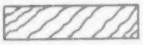
______ g. 

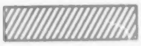
______ h. 

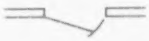
______ i.

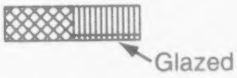
______ j. 

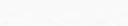
______ k. 

______ l. 

______ m. 

______ n. 

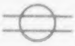
______ o. 

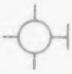
______ p. 

1. Brick veneer
2. Arch—cased opening
3. Casement window
4. Earth
5. Gravel
6. Telephone jack
7. Structural—steel or iron
8. Insulation
9. Flashing, termite barrier, waterproofing
10. Tile—hollow, terra cotta
11. Inside door
12. Wood—rough
13. Wood—finished
14. Brick
15. Floor drain
16. Glass

Written Test

- Electrical symbols

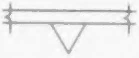
_______ q. 

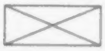
_______ r. 

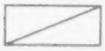
_______ s. S_1

17. Wall bracket outlet
18. Duplex outlet
19. Switch—single pole

- Other symbols

_______ t. 

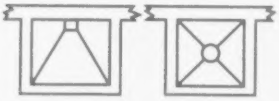
_______ u. 

_______ v. 

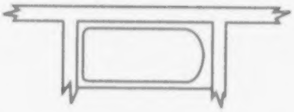
20. Vacuum outlet
21. Supply air duct
22. Return air duct

5. Identify plumbing, appliance, and structural symbols. Write your answers in the blanks provided.

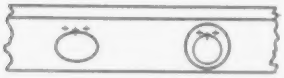
- Plumbing symbols



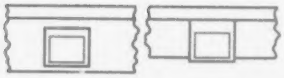
a. _______________________________



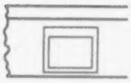
b. _______________________________



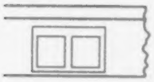
c. _______________________________



d. _______________________________

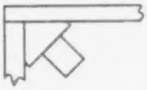


e. _______________________________

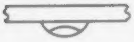


f. _______________________________

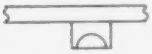
Written Test



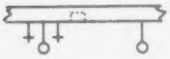
g. ______________________________



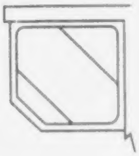
h. ______________________________



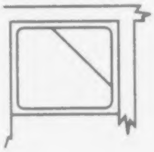
i. ______________________________



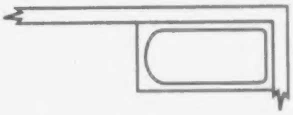
j. ______________________________



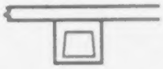
k. ______________________________



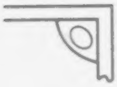
l. ______________________________



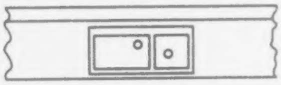
m. ______________________________



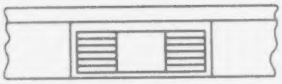
n. ______________________________



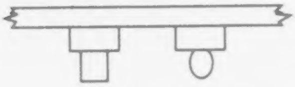
o. ______________________________



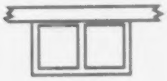
p. ______________________________



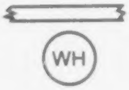
q. ______________________________



r. ______________________________



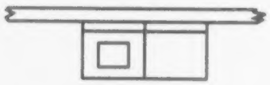
s. ______________________________



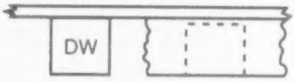
t. ______________________________

Written Test

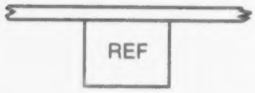
- Appliance symbols



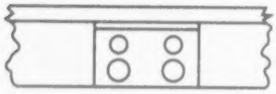
a. ______________________________



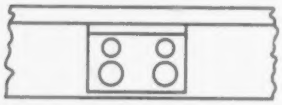
b. ______________________________



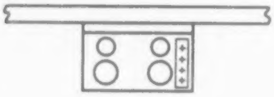
c. ______________________________



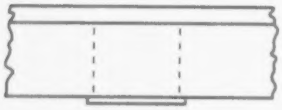
d. ______________________________



e. ______________________________

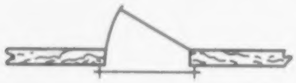


f. ______________________________

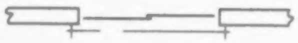


g. ______________________________

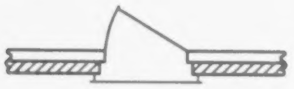
- Structural symbols



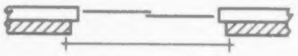
a. ______________________________



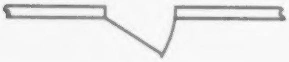
b. ______________________________



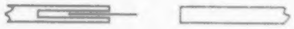
c. ______________________________



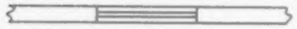
d. ______________________________



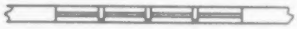
e. ______________________________



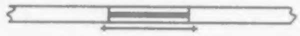
f. ______________________________



g. ______________________________



h. ______________________________



i. ______________________________

Written Test

6. Match the piping and fitting or valve names on the right with their correct symbols.

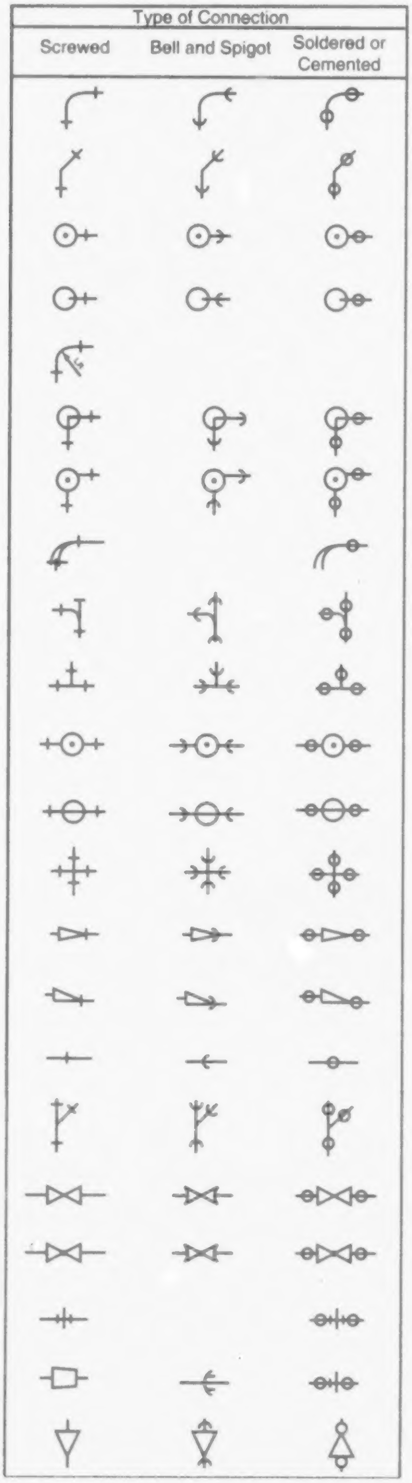
Note: Answers for a–w are on this page.

_____ a. ————————
_____ b. ——— ——— ———
_____ c. — — — — —
_____ d. ——— SD ———
_____ e. —— – ———— – –
_____ f. ——— SW ———
_____ g. —— - - ———— - - -
_____ h. ——— S ———
_____ i. ——○————○——
_____ j. ——— G — G ———
_____ k. ——— A ———
_____ l. ——— V ———
_____ m. ———S-CI———
_____ n. ———S-CT———
_____ o. ———S-P———
_____ p. ——//————//——
_____ q. ——/———/———/——
_____ r. ————————
_____ s. ——— FOS ———
_____ t. ——— HW ———
_____ u. ——— HWR ———
_____ v. ——— C ———
_____ w. ——— RL ———

1. Soft cold water
2. Vacuum
3. Low-pressure steam
4. Hot water heating return
5. Drain or waste above ground
6. Hot water
7. Compressed air
8. Medium-pressure steam
9. Vent
10. Sewer—cast iron
11. Fuel oil supply
12. Storm drain
13. Drain or waste below ground
14. Sprinkler branch and head
15. Sewer—plastic
16. Hot water heating supply
17. Gas
18. Cold water
19. Sewer—clay tile
20. High-pressure steam
21. Sprinkler main
22. Condenser water supply
23. Refrigerant liquid

Written Test

Note: Answers for x–ss are on this page.



______ x.
______ y.
______ z.
______ aa.
______ bb.
______ cc.
______ dd.
______ ee.
______ ff.
______ gg.
______ hh.
______ ii.
______ jj.
______ kk.
______ ll.
______ mm.
______ nn.
______ oo.
______ pp.
______ qq.
______ rr.
______ ss.

24. Sanitary T
25. Connector
26. Increaser
27. Elbow—90°
28. Elbow—long radius
29. T—outlet up
30. Y or wye
31. Union
32. Elbow—45°
33. Elbow with side inlet—outlet up
34. Reducer—concentric
35. Valve—gate
36. Bushing
37. Elbow—turned up
38. Reducing elbow
39. T—outlet down
40. Reducer—offset (eccentric)
41. Cross
42. Valve—globe
43. Elbow with side inlet—outlet down
44. T
45. Elbow—turned down

Written Test

7. List six major items that should be included in a set of specifications.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

8. Find the specific information from the detailed specifications statement below. Write your answers in the blanks provided on the following page.

This contractor shall install a complete plumbing system as per these plans and specifications.

All water piping shall be copper type "L."

All above ground drainage and vent piping shall be copper DWV.

Underground drainage pipe shall be cast iron.

All plumbing must adhere to the local plumbing code.

Building drain must be connected to city sewer lateral at curb.

Service pipe must be copper type "K" and connected at curb and meter.

All fixtures must be provided with shock arrestors on their water distribution pipes.

Outside sillcocks must be 12" freeze-proof type.

Fixtures:

Kitchen Sink—Acme "Master Chef" #7940—White

Bath—Acme "Salt Wara" #8016—White

Lavatory—Acme "Hanwas" #122—White

Water Closet—Acme "Wasam" #16—White

Sink fitting—Groget "Klin" #8786

Lavatory fitting—Groget "Nogot" #88

Bath-Shower fitting—Groget "Long Wara" #32 124

The owner reserves the right to make changes by negotiating the contract.

Written Test

a. Color of bathtub fixture ______________________

b. Manufacturer of kitchen sink ______________________

c. Material and type for service pipe ______________________

d. Location of shock arrestors ______________________

e. Plumbing code to adhere to ______________________

f. Material and type of water pipe ______________________

g. Material and type of underground pipe ______________________

h. Type of sillcocks ______________________

i. City sewer lateral location ______________________

j. Material and type of vent piping ______________________

9. Select true statements about reading an architect's scale by placing an "X" in the blanks next to the true statements.

_____ a. Check the title block to find the scale used on the drawing.

_____ b. Measure in a different scale ratio to the one in which the drawing was prepared.

_____ c. Lay the scale flat on the surface being measured.

_____ d. Check all measurements only once.

_____ e. Measure from the center of one line to the center of the next line.

_____ f. Always scale a drawing, even when dimensions are available.

Permission to duplicate this test is granted.

Blueprint Reading
Unit 1-C

Answers to Written Test

1.
a. 11
b. 14
c. 12
d. 13
e. 5
f. 3
g. 6
h. 1
i. 7
j. 9
k. 2
l. 8
m. 15
n. 4
o. 10

2. Any four of the following:
- Plot plan
- Foundation plan
- Floor plan
- Elevation
- Detail

3.
a. 8
b. 6
c. 7
d. 5
e. 4
f. 1
g. 9
h. 2
i. 3

4.
a. 4
b. 5
c. 7
d. 2
e. 3
f. 8
g. 9
h. 1
i. 6
j. 15
k. 12
l. 13
m. 14
n. 11
o. 10
p. 16
q. 18
r. 17
s. 19
t. 20
u. 21
v. 22

5. Plumbing symbols
a. Showers
b. Built-in bathtub (recessed)
c. Built-in lavatories
d. Built-in lavatories
e. Single-bowl sink
f. Double-bowl sink
g. Corner water closet
h. Wall urinal
i. Urinal
j. Shower heads
k. Square corner bathtub
l. Built-in square bathtub
m. Corner bathtub
n. Wall-hung lavatory
o. Corner lavatory
p. Shallow bowl sink
q. Double drainboard sink with cabinet

Answers to Written Test

r. Toilet stools or Water closets
s. Laundry tubs
t. Water heater

Appliance symbols
a. Washer and dryer
b. Freestanding and built-in dishwashers
c. Refrigerator or freezer
d. Freestanding range
e. Drop-in range
f. Surface cook top
g. Built-in oven

Structural symbols
a. Exterior door in wood frame wall
b. Exterior sliding door in wood frame wall
c. Exterior door in masonry veneer wall
d. Exterior sliding door in masonry veneer wall
e. Interior hinged door
f. Interior pocket door
g. Single window in frame wall
h. Multiple windows in frame wall
i. Double hung window in frame wall

6.
a. 5 or 3
b. 13
c. 9
d. 12
e. 18
f. 1
g. 6
h. 21
i. 14
j. 17
k. 7
l. 2
m. 10
n. 19
o. 15
p. 20
q. 8
r. 3 or 5
s. 11
t. 16
u. 4
v. 22
w. 23
x. 27
y. 32
z. 37
aa. 45
bb. 28
cc. 43
dd. 33
ee. 38
ff. 24
gg. 44
hh. 29
ii. 39
jj. 41
kk. 34
ll. 40
mm. 25
nn. 30
oo. 35
pp. 42
qq. 31
rr. 36
ss. 26

7. Any six of the following:
- Manufacturer, style, size, and identification numbers of building materials
- Quality of building materials
- Standards and methods of construction
- Types of materials
- Quality and manner of workmanship
- All plumbing operations to be performed
- Reference to detailed working drawings
- Owner's name and address
- Contractor's name and address
- Location of new structure
- Completion date
- Contractor's bid
- Guarantees
- Method of payment

Answers to Written Test

8.
   a. White
   b. Acme
   c. Copper type "K"
   d. Water distribution pipes on all fixtures
   e. Local plumbing code
   f. Copper type "L"
   g. Cast iron
   h. 12" freeze-proof type
   i. Curb
   j. Copper DWV

9. a, c, e

Blueprint Reading
Unit 1-C

Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Assignment Sheet Ratings

Assignment Sheet 1—Read the Architect's Scale at 1/4″ = 1′ Rating ________

Comments: ______________________

____

Assignment Sheet 2—Read the Architect's Scale at 1/8″ = 1′ Rating ________

Comments: ______________________

____

Assignment Sheet 3—Read the Architect's Scale at 1″ = 20′ Rating ________

Comments: ______________________

____

Assignment Sheet 4—Read the Architect's Scale at 1″ = 50′ Rating ________

Comments: ______________________

____

Assignment Sheet 5—Determine Dimensions on a Drawing Using an Architect's Scale Rating ________

Comments: ______________________

____

Written Test Scores

Pretest ________ Posttest ________ Other ________

Other ______________________

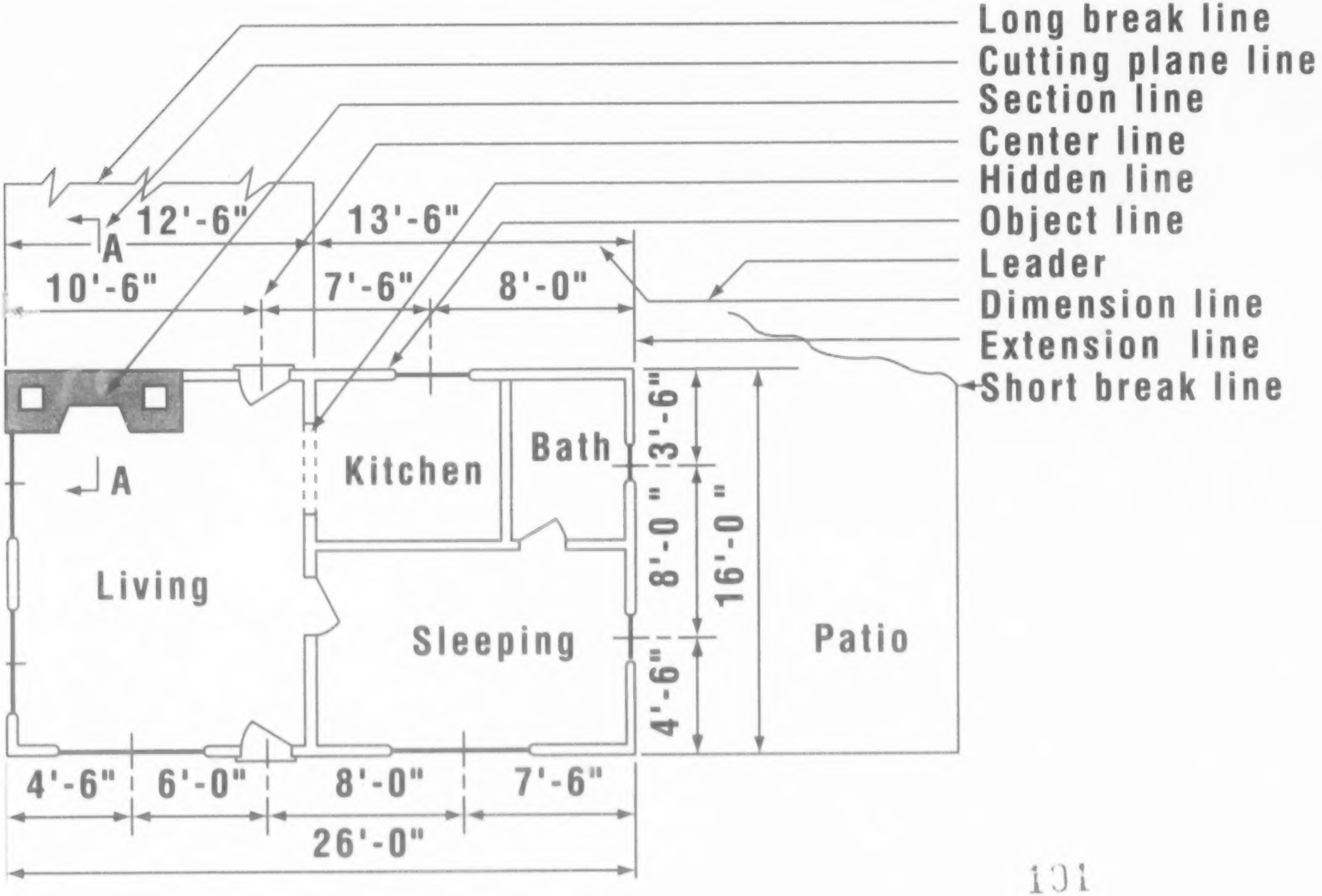
____

Teacher Signature ______________________ Date __________

Student Signature ______________________ Date __________

Permission to duplicate this form is granted.

Alphabet of Lines



Sketches and Diagrams for Plumbers
Unit 2-C

Unit Contents

Teacher Components **Page**

Suggested Activities 3
Answers to Assignment Sheets 7
Written Test 9
Answers to Written Test 11
Unit Evaluation Form 13

Transparency Masters

1—Plan View Sketches 15
2—Riser Diagrams 17
3—Isometric Sketch 19

Student Components **Page**

Objective Sheet C-57
Information Sheet C-59

Assignment Sheets

1—Develop Three Types of Sketches of a Drainage System in a Basement Floor C-63
2—Develop an Isometric Sketch of a Drainage System C-65

Sketches and Diagrams for Plumbers
Unit 2-C

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resources Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Make transparencies from the transparency masters included in this unit.
- Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

Unit Introduction

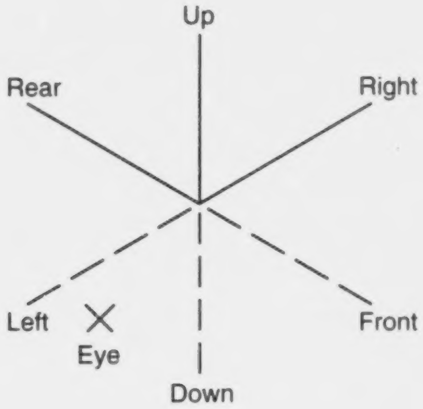
- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss the assignment sheets. Review with students the criteria for evaluation of these activities.

Suggested Activities

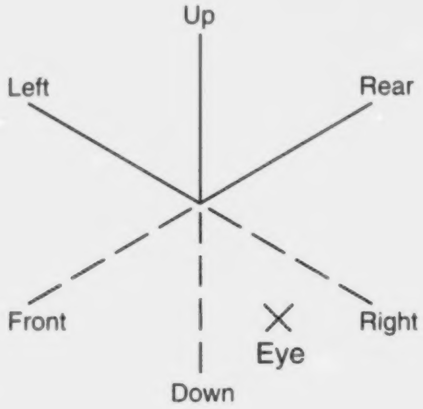
Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Provide examples of isometric sketches. **(Seeing things in the mind's eye; and interpretation)**
- Have the students trace available isometric sketches to become more familiar with the technique of isometric drawing. **(Seeing things in the mind's eye; and interpretation)**
- Draw the following illustration on the chalk board. It will show how isometrics can best be understood by visualizing a house from a 30° angle with either the left or right eye. **(Seeing things in the mind's eye; and interpretation)**



Isometric Directions
Left Front Eye Position



Isometric Directions
Right Front Eye Position

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.
- Make copies of the written test. Add or modify test items as needed.
- Give and evaluate written test.
- Compile the assignment sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignments or supplemental activities that should be part of the unit evaluation.

Suggested Activities

- Meet individually with students to evaluate their progress through this unit of instruction and indicate to them possible areas of improvement.
- Reteach and retest as required.

Resources Used in Developing This Unit

- Barclay, Leney. *Residential Plumbing*. Revised by Hank Johnson. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1985.
- Blankenbaker, Keith E. *Modern Plumbing*. South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.

Suggested Supplemental Resources

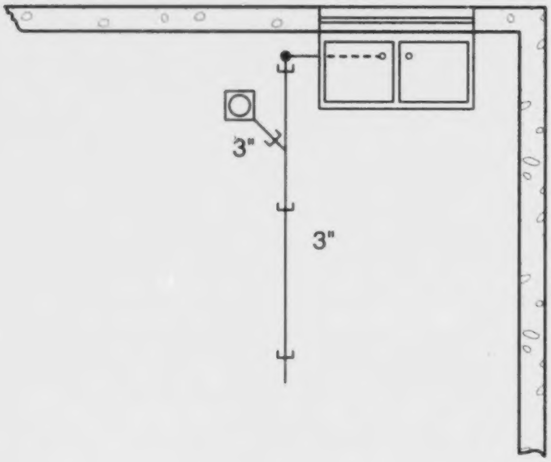
- Massey, Howard C. *Plumber's Exam*. 5th ed. Carlsbad, CA: Craftsman Book Company, 1996.
- Massey, Howard. C. *Plumber's Handbook*. 5th ed. Carlsbad, CA: Craftsman Book Company, 1994.

Sketches and Diagrams for Plumbers
Unit 2-C

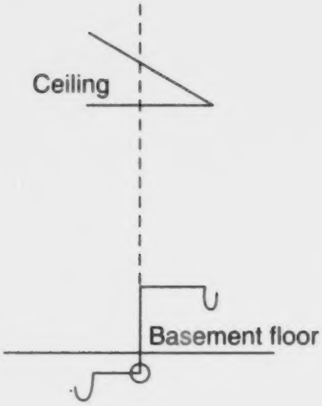
Answers to Assignment Sheets

Assignment Sheet 1—Develop Three Types of Sketches of a Drainage System in a Basement Floor

A.



B.



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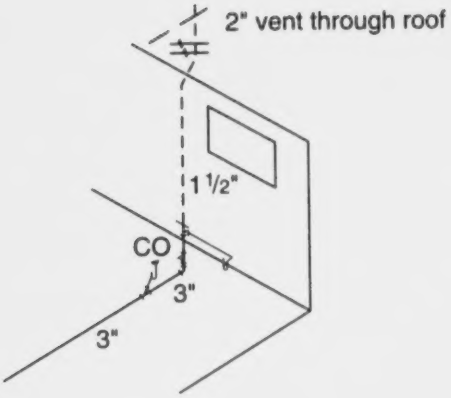
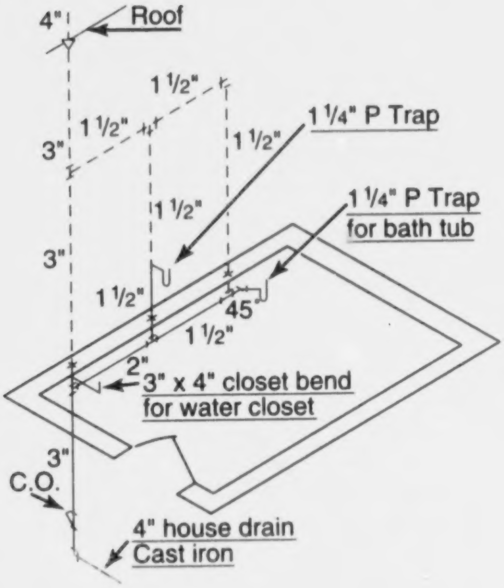
C.



Assignment Sheet 2—Develop an Isometric Sketch of a Drainage System



Sketches and Diagrams for Plumbers
Unit 2-C

Written Test

Name ______________________________ Date ____________ Score ____________

1. Select true statements concerning characteristics of a plan view sketch by placing an "X" in the blanks next to the true statements.

_______ a. A plan view sketch shows the structure as viewed from the side.

_______ b. A plan view sketch does not show pitch of pipe.

_______ c. A plan view sketch can be used to determine length of pipe.

_______ d. A plan view sketch can be used to determine direction of flow.

_______ e. A plan view sketch can be used to determine labor estimates.

_______ f. A plan view sketch can be used to determine height of sink.

_______ g. A plan view sketch cannot serve as a record after the floor has been poured.

_______ h. A plan view sketch should show all drainage including storm drainage and foundation drainage.

2. Select true statements concerning characteristics of a riser diagram by placing an "X" in the blanks next to the true statements.

_______ a. A riser diagram is valuable in determining code and inspection requirements.

_______ b. A riser diagram is a true picture of the sketch since it is three dimensional.

_______ c. A riser diagram is a sectional view (schematic) through a building that shows the piping system or part of the system.

3. Select true statements concerning characteristics of an isometric sketch by placing an "X" in the blanks next to the true statements.

_______ a. An isometric sketch is a three-dimensional representation.

_______ b. Isometrics combine the take-off view and elevation view into one drawing.

_______ c. Scaled isometric views help to determine an accurate materials list.

_______ d. Pipes that are vertical on a plan or elevation view, such as soil, water, and vent stacks, are vertical in an isometric drawing.

_______ e. Pipes that are diagonal on a plan or elevation view are shown at a 30° angle in the isometric drawing.

Permission to duplicate this test is granted.

Sketches and Diagrams for Plumbers
Unit 2-C

Answers to Written Test

1. b, c, d, e, h
2. a, c
3. a, c, d

Sketches and Diagrams for Plumbers
Unit 2-C

Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Assignment Sheet Ratings

Assignment Sheet 1— Develop Three Types of Sketches of a Drainage System in a Basement Floor Rating ________

Comments: ______________________

____

Assignment Sheet 2—Develop an Isometric Sketch of a Drainage System Rating ________

Comments: ______________________

____

Written Test Scores

Pretest ________ Posttest ________ Other ________

Other ______________________

____

Teacher Signature ______________________ Date __________

Student Signature ______________________ Date __________

Permission to duplicate this form is granted.

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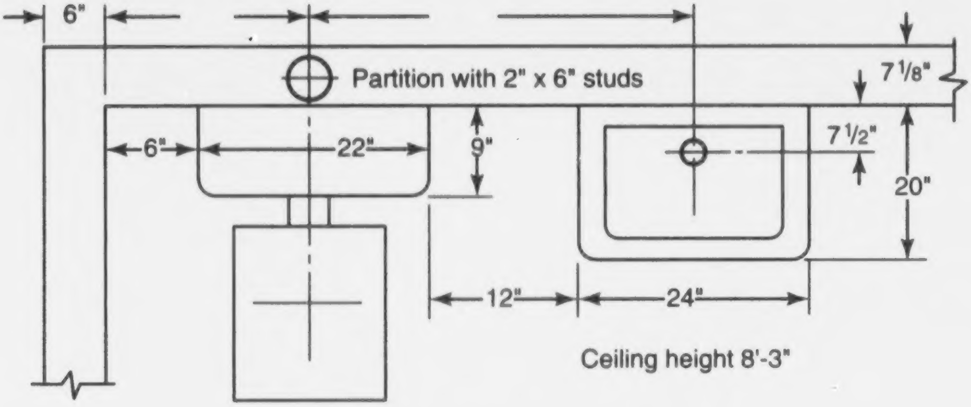
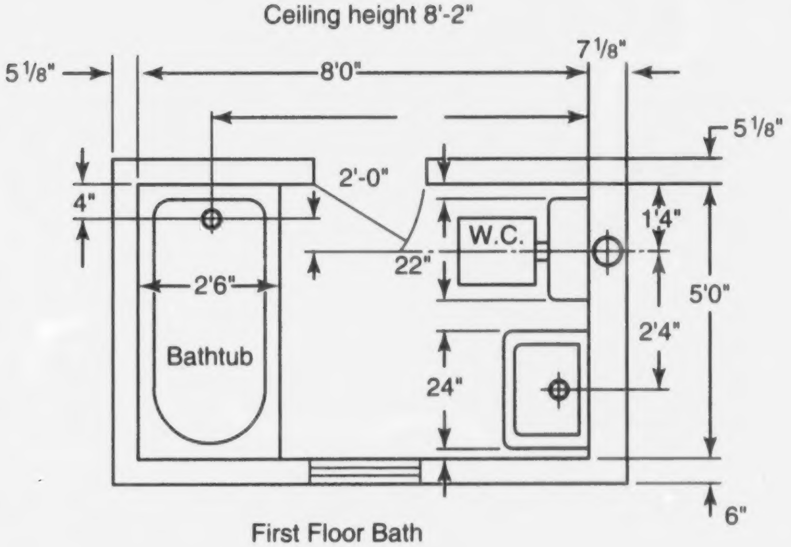
Plan View Sketches



Roof line 9" above ceiling line

House drain 4'-6" below first floor line

No cellar—crawl space only



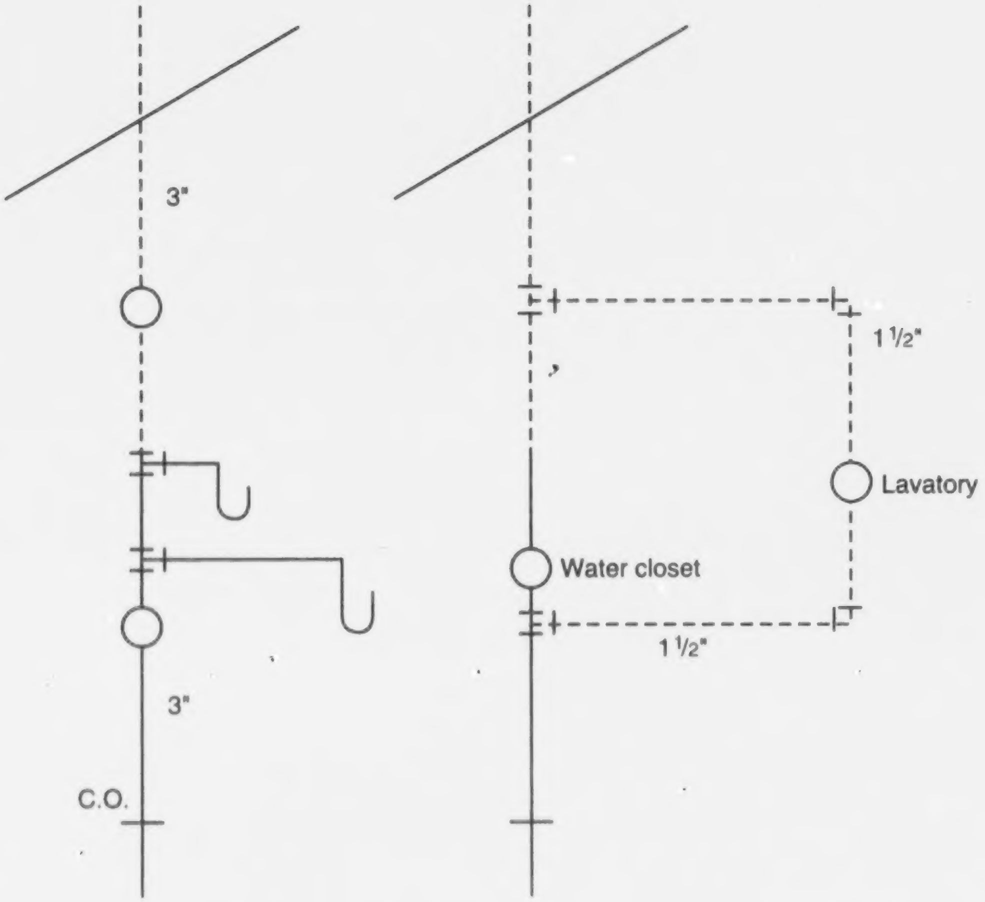
First Floor Bath

Roof line 3'9" above ceiling line

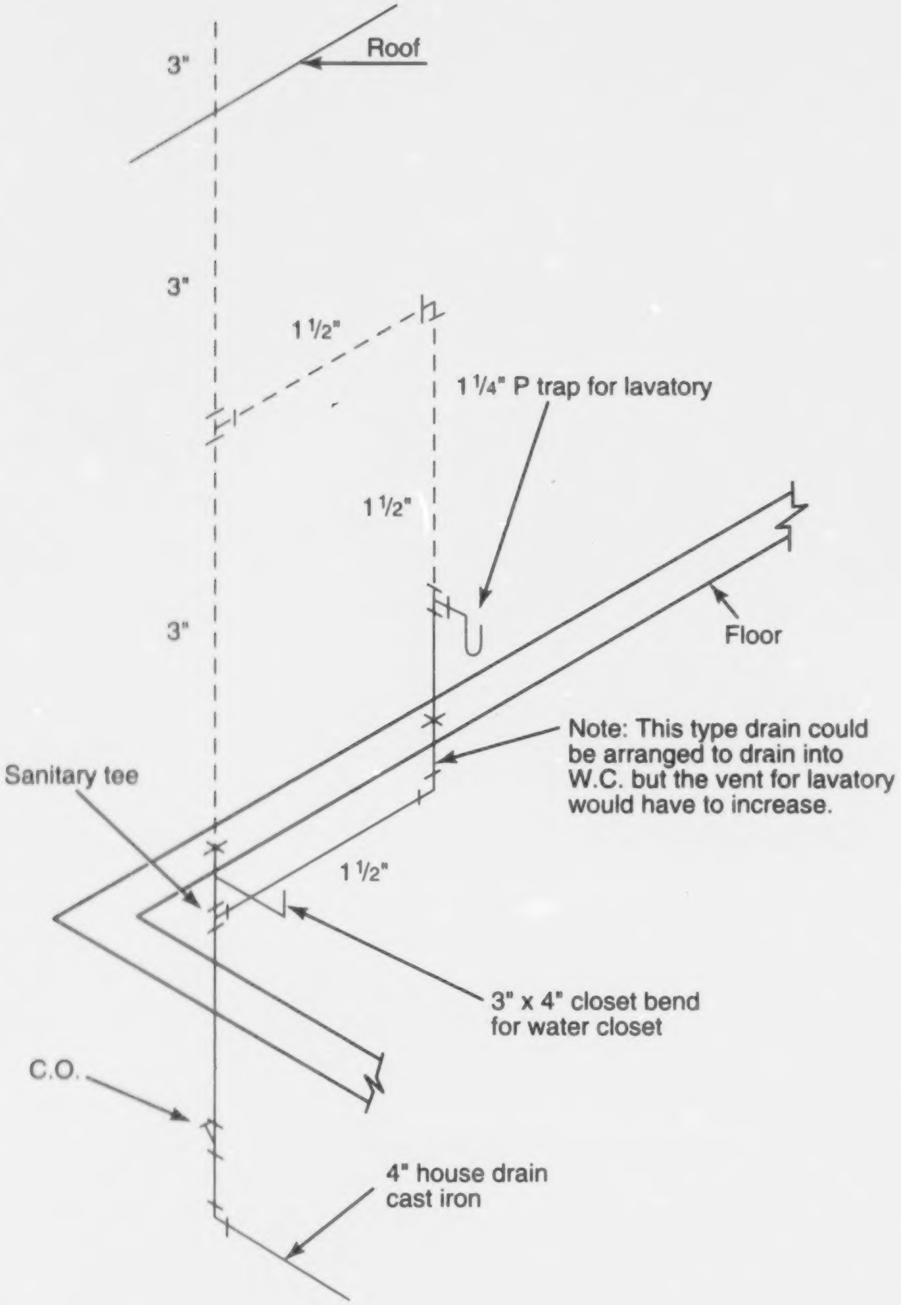
Basement floor 8'-0" below first floor

House drain 8'-8" below first floor

Riser Diagrams



Isometric Sketch


3"
Roof
3"
1 1/2"
1 1/4" P trap for lavatory
1 1/2"
3"
Floor
Note: This type drain could be arranged to drain into W.C. but the vent for lavatory would have to increase.
Sanitary tee
1 1/2"
3" x 4" closet bend for water closet
C.O.
4" house drain cast iron

Rough-In Locations
Unit 3-C

Unit Contents

Teacher Components **Page**

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Answers to Assignment Sheet 7
Written Test 9
Answers to Written Test 13
Unit Evaluation Form 15
Transparency Masters
  1—Manufacturer's Specifications—Water Closet Rough-In Sheet 17
  2—Manufacturer's Specifications—Bathtub Rough-In Sheet 19
  3—Manufacturer's Specifications—Countertop Lavatory Rough-In Sheet 21
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Student Components **Page**

Objective Sheet C-67
Information Sheet C-69
Assignment Sheet 1—Determine Measurements From a
  Manufacturer's Specifications C-77
Job Sheets
  1—Determine Rough-In Locations for a Bathroom C-81
  2—Establish Grade Lines for Installing Plumbing C-87

Rough-In Locations
Unit 3-C

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resources Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Make transparencies from the transparency masters included in this unit.
- Review "Instructions for Evaluating Student Performance."
- Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

Unit Introduction

- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss the assignment sheet. Review with students the criteria for evaluation of these activities.
- Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and materials are available. Review criteria for evaluation of these activities.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Conduct a field trip to a construction site. Discuss the building plans and the rough-in plumbing with the students. **(Mathematics; listening; speaking; seeing things in the mind's eye; and information acquisition and evaluation and interpretation)**
- Discuss the duties and responsibilities of other residential construction tradesworkers and how they can affect a plumber's work. **(Listening; speaking; organizational effectiveness; and teamwork)**
- Discuss why accurate rough-in locations are important. **(Mathematics; listening; and speaking)**
- Compile a timetable for the construction of a home. Indicate when each tradesworker comes on the job site and the length of time they normally need to complete their part of the job. **(Mathematics; time; human resources; organizational effectiveness; and teamwork)**
- Provide copies of different manufacturer's specifications for the students to read and compare. **(Reading; Mathematics; seeing things in the mind's eye; and information interpretation)**
- Discuss the importance of cooperation on the job site; discuss personal experiences when cooperation was and was not used. **(Listening; speaking; organizational effectiveness; and teamwork)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.
- Make copies of the written test. Add or modify test items as needed.
- Give and evaluate written test.
- Compile the assignment sheet and job sheet ratings and written test scores on the Unit Evaluation Forms. Include any additional assignments or supplemental activities that should be part of the unit evaluation.
- Meet individually with students to evaluate their progress through this unit of instruction and indicate to them possible areas of improvement.
- Reteach and retest as required.

Suggested Activities

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

Resources Used in Developing This Unit

- Barclay, Leney. *Residential Plumbing*. Revised by Hank Johnson. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1985.
- Blankenbaker, Keith E. *Modern Plumbing*. South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.

Suggested Supplemental Resources

- Massey, Howard C. *Plumber's Exam*. 5th ed. Carlsbad, CA: Craftsman Book Company, 1996.
- Massey, Howard C. *Plumber's Handbook*. 5th ed. Carlsbad, CA: Craftsman Book Company, 1994.

Rough-In Locations
Unit 3-C

Answers to Assignment Sheet 1—Determine Measurements From a Manufacturer's Specifications

1.
   a. 14 1/2″
   b. 28 3/4″
   c. 14″
   d. 9 1/2″
   e. 27 1/4″

2.
   a. 19″
   b. 19 1/4″
   c. 12 7/8″
   d. 14 3/8″
   e. 4″ or 8″
   f. 6 1/4″

3.
   a. 34 1/4″
   b. 60″
   c. 18 1/4″
   d. 14″
   e. 4″
   f. 78″
   g. 48″

Rough-In Locations
Unit 3-C

Written Test

Name ______________________ Date __________ Score __________

1. Match the terms on the right with the correct definitions.

________ a. Preparing for and installing those pipes which will be covered by walls, ceilings, floors, and could be exposed in the basement

________ b. Drawings and directions supplied by fixture manufacturers which indicate exact size, shape, and connections necessary to install the fixture

________ c. Concrete poured in a large flat surface which includes the entire house floor

________ d. Wood beams, usually 2″ x 8″, which are used to support the floor or ceiling

________ e. Wood beams, usually 2″ x 4″, which are used to support wall materials such as plasterboard, plaster, or paneling

________ f. Consists of a sub-floor (on base) and the finish floor

________ g. People engaged in various trades involved in the construction of buildings and other structures

________ h. Drawings (usually hand drawn) showing all the piping arrangement and information needed to install the piping

________ i. A plumber who is licensed to design, interpret, and install plumbing systems

________ j. The base of a studded wall; sometimes called the sole plate

1. Journeyman plumber
2. Tradesworkers
3. Plate
4. Flooring
5. Manufacturer's specifications
6. Slab construction
7. Studs
8. Sketches
9. Floor and ceiling joists
10. Rough-in

2. List three individuals who could be responsible for determining rough-in locations.

a. ______________________________

b. ______________________________

c. ______________________________

Written Test

3. Select true statements concerning verbal orders by placing an "X" in the blanks next to the true statements.

________ a. Verbal orders should be clearly understood by both parties.

________ b. The plumber should keep clearly written notes about verbal orders, with dates and specific information.

________ c. Verbal orders from unfamiliar people should be verified by the person who does the carpentry.

________ d. Change orders must be verified and signed by the employer or immediate superior.

________ e. Verbal orders do not need to be acknowledged.

________ f. Persons giving verbal orders should be told to mind their own business.

4. Select true statements concerning sketches by placing an "X" in the blanks next to the true statements.

________ a. Sketches are prepared by the employer, foreman, customer, and/or worker.

________ b. Workers should wait until they get to job site to discuss sketches.

________ c. Workers should keep sketches in a safe place until the job is approved.

________ d. The worker in charge of an installation should ask permission of employer and customer before revising a sketch of the project.

5. Complete the following statements concerning marking out locations by filling in the blanks with the correct words.

a. Usually the ____________________________ measures and marks out the locations using the rough-in book.

b. Floor and ceiling joist locations and ______________________ locations must be taken into consideration when marking locations for holes and openings.

c. Holes for ______________________ must be in perfect position.

d. Holes for lavatory and sink drains can be offset __________________inches.

e. Concrete slab and basement floor installations are usually done ______________________ the initial building foundation has been installed.

6. Select information commonly found on manufacturer's specifications by placing an "X" in the blanks next to items that would be found on specifications.

________ a. Centerline of drain outlet

________ b. Centerline of water supply

________ c. Height of fixture

_______ d. Width of fixture

_______ e. Depth of fixture

_______ f. Height of water supply from ceiling

_______ g. Height of drain outlet from rough floor

_______ h. Piping arrangement

_______ i. Rough-in location of rough frame (stud wall)

7. List two pieces of information which can be determined from manufacturer's specifications.

   a. ______________________________

   b. ______________________________

8. List seven residential construction tradesworkers.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

   e. ______________________________

   f. ______________________________

   g. ______________________________

9. Discuss cooperating and coordinating techniques between plumbers and other tradesworkers.

____

____

____

____

____

____

____

____

____

Permission to duplicate this test is granted.

Rough-In Locations
Unit 3-C

Answers to Written Test

1.
   - a. 10
   - b. 5
   - c. 6
   - d. 9
   - e. 7
   - f. 4
   - g. 2
   - h. 8
   - i. 1
   - j. 3

2.
   - Employer
   - Customer
   - Journeyman plumber

3. a, b, d

4. a, c

5.
   - a. Journeyman plumber
   - b. Stud (or plasterboard nails and other nailings)
   - c. Any of the following: water closet, shower, and bathtub drains
   - d. 1–2
   - e. After

6. a, b, c, d, e, g, i

7.
   - Changes in wall structure
   - Location of wall supports

8. Answer should include any seven of the following:
   - Plumbers
   - Masons or bricklayers
   - Carpenters
   - Electricians
   - Drywall installers, tapers
   - Roofers
   - Telephone installers
   - Heating and air-conditioning installers
   - Tile setters
   - Painters
   - Flooring installers

9. Discussion should include:
   - Respect the codes and regulations of other tradesworkers.
   - Give consideration to other tradesworkers' work.
   - A good employer or supervisor encourages each worker to own and carry his/her own tools and also discourages borrowing.
   - Use caution in lending tools to fellow workers.
   - Do not use an extension cord that other tradesworkers are using; this can cause inconvenience.
   - Have a friendly attitude toward other tradesworkers; unfriendly attitudes can cause aggravation and additional work.

Rough-In Locations
Unit 3-C

Unit Evaluation Form

Student Name ______________________ Unit Rating ____________

Assignment Sheet Rating

Assignment Sheet 1—Determine Measurements From a Manufacturer's Specifications Rating ________

Comments: ______________________________________

____

Job Sheet Ratings

Job Sheet 1—Determine Rough-In Locations for a Bathroom Rating ________

Comments: ______________________________________

____

Job Sheet 2—Establish Grade Lines for Installing Plumbing Rating ________

Comments: ______________________________________

____

Written Test Scores

Pretest ________ Posttest ________ Other ________

Other ______________________________________

____

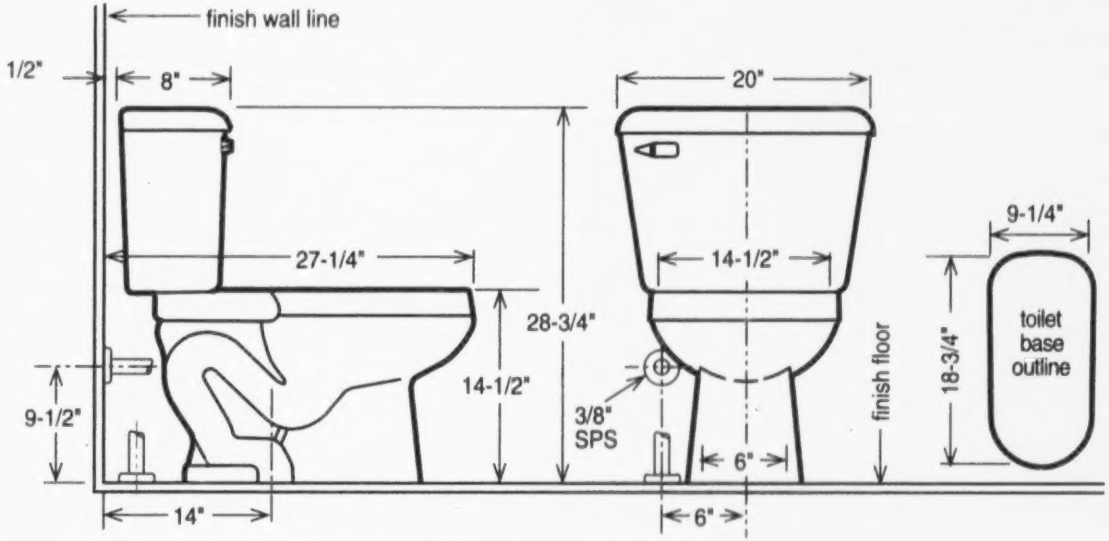
Teacher Signature ______________________ Date ____________

Student Signature ______________________ Date ____________

Permission to duplicate this form is granted.

Manufacturer's Specifications

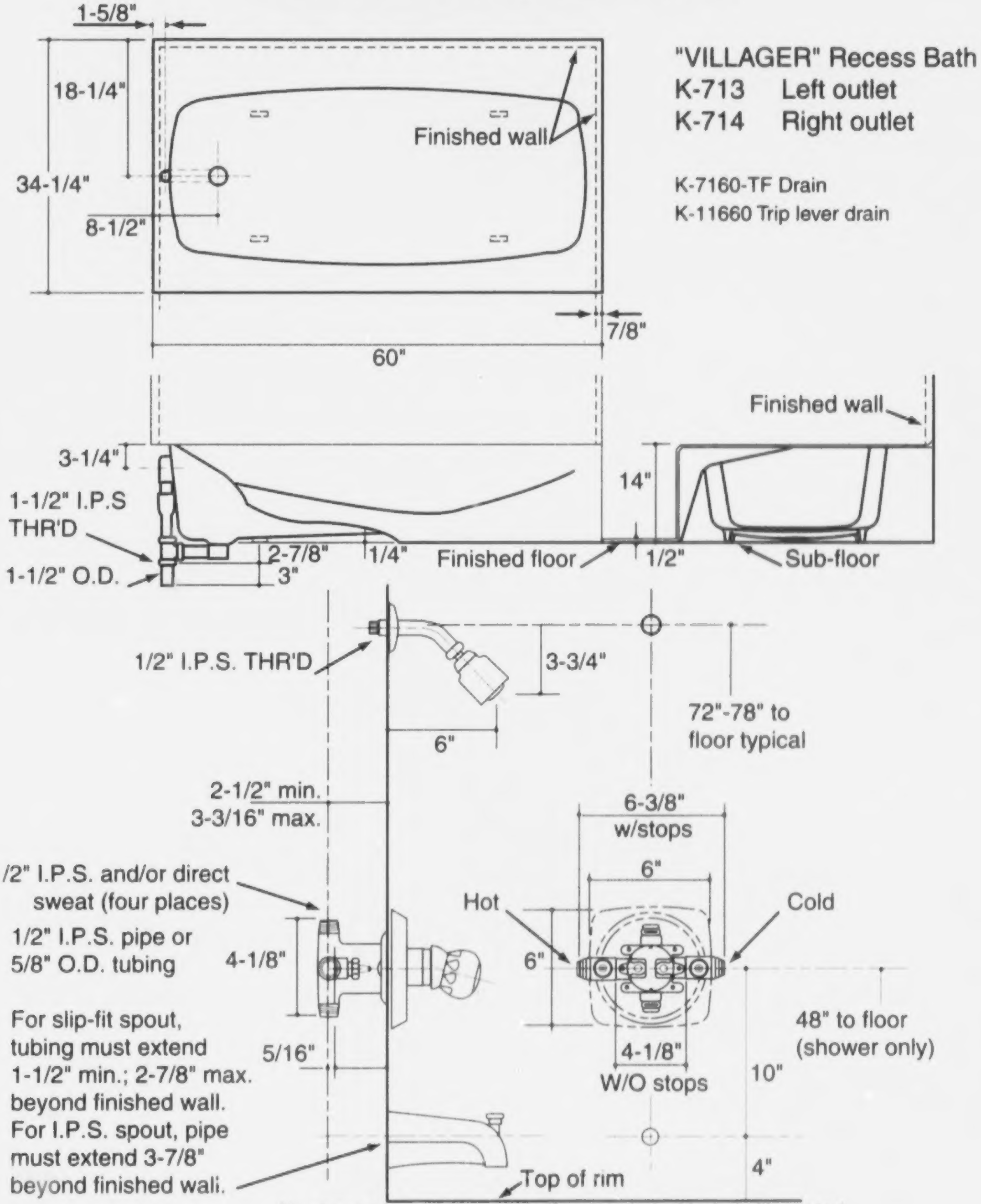
Water Closet Rough-In Sheet



Information provided by Mansfield Plumbing Products, Inc....America's Best Value!

Manufacturer's Specifications

Bathtub Rough-In Sheet



"VILLAGER" Recess Bath
K-713 Left outlet
K-714 Right outlet

K-7160-TF Drain
K-11660 Trip lever drain

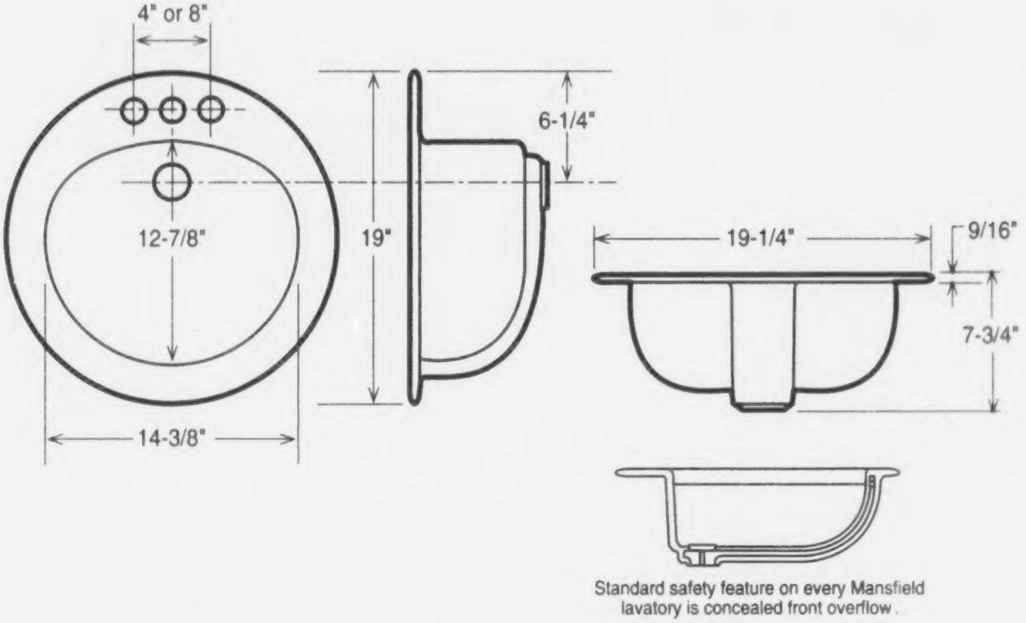
For slip-fit spout, tubing must extend 1-1/2" min.; 2-7/8" max. beyond finished wall. For I.P.S. spout, pipe must extend 3-7/8" beyond finished wall.

No change in measurements if connected with drain illustrated.

Courtesy of Kohler Co.

Manufacturer's Specifications

Countertop Lavatory Rough-In Sheet



Standard safety feature on every Mansfield lavatory is concealed front overflow.

Information provided by Mansfield Plumbing Products, Inc....America's Best Value!

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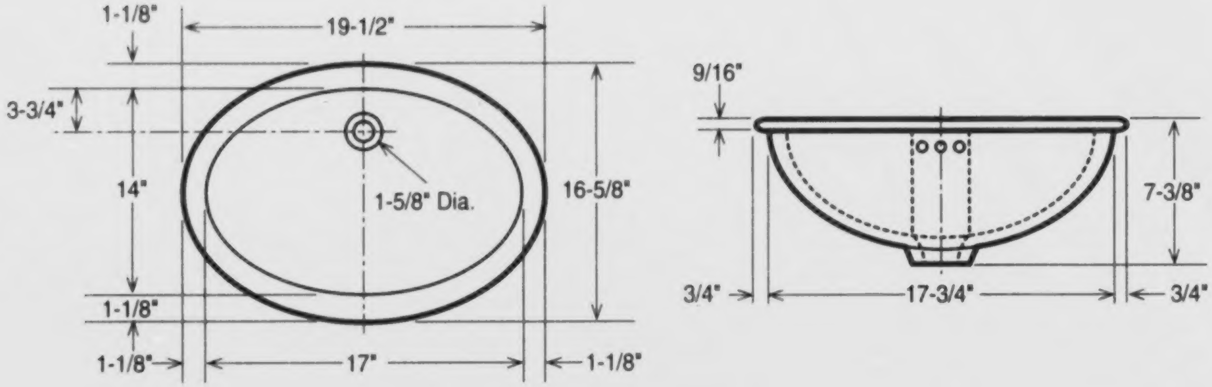
Manufacturer's Specifications

Under-Counter Lavatory Rough-In Sheet



Information provided by Mansfield Plumbing Products, Inc....America's Best Value!

Building and Plumbing Codes
Unit 4-C

Unit Contents

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Assignment Sheets
  1—Apply Code Regulations to a Plumbing Installation C-99
  2—Use the BOCA Basic/National Plumbing Code C-101

Building and Plumbing Codes
Unit 4-C

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resources Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

Unit Introduction

- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss the assignment sheets. Review with students the criteria for evaluation of these activities.

Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Discuss the differences between your local code and the BOCA Basic/National Plumbing Code. **(Reading; listening; speaking; information acquisition and evaluation and interpretation)**
- Invite a local plumbing inspector to speak to the class about plumbing codes, the importance of following them, and the consequences of not following them. **(Listening; speaking; responsibility; integrity/honesty; and customer service)**

Suggested Activities

- Assign the local plumbing code handbook as required reading and test as needed. **(Reading; and information interpretation)**
- Show and discuss with the students examples of when the plumbing code was not followed. **(Listening; speaking; responsibility; integrity/honesty; and customer service)**
- Provide copies of the latest BOCA Basic/National Plumbing Code for students to use to complete the assignment sheets. **(Reading; information acquisition and evaluation and interpretation)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.
- Make copies of the written test. Add or modify test items as needed.
- Give written test.
- Compile the assignment sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignments or supplemental activities that should be part of the unit evaluation.
- Meet individually with students to evaluate their progress through this unit of instruction and indicate to them possible areas of improvement.
- Reteach and retest as required.

Resources Used in Developing This Unit

- Barclay, Leney. *Residential Plumbing.* Revised by Hank Johnson. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1985.
- Blankenbaker, Keith E. *Modern Plumbing.* South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.

Suggested Supplemental Resources

- Massey, Howard C. *Plumber's Exam.* 5th ed. Carlsbad, CA: Craftsman Book Company, 1996.
- Massey, Howard C. *Plumber's Handbook.* 5th ed. Carlsbad, CA: Craftsman Book Company, 1994.

Building and Plumbing Codes
Unit 4-C

Answers to Assignment Sheets

Assignment Sheet 1—Apply Code Regulations to a Plumbing Installation

A. 3" x 2" sanitary tee
B. 2" Y
C. 3" sanitary tee
D. 2" x 1 1/2" double sanitary tee
E. 2" 90° el
F. 3" x 2" sanitary tee
G. 4" C.I. Y and 1/8th bend

Assignment Sheet 2—Use the BOCA Basic/National Plumbing Code

1. b
2. a
3. b
4. d
5. c
6. a
7. c
8. d
9. a
10. c

Building and Plumbing Codes
Unit 4-C

Written Test

Name ______________________ Date __________ Score __________

1. Match the terms on the right with the correct definitions.

_____ a. Set of rules governing the quality of construction in a community

_____ b. Set of rules governing the quality of plumbing installations

_____ c. Person authorized to inspect and approve or disapprove plumbing installations according to code specifications

_____ d. Rules which specify type of construction permitted in certain areas of a city or town

_____ e. Checking to see if the work conforms to the code specifications

_____ f. Plumbing code resulting in 1982 from an agreement between the Building Officials and Code Administration (BOCA) and the American Insurance Association (AIA) which is generally accepted as a basis for developing state and local plumbing codes through much of the country

_____ g. Document stating that the holder has passed trade tests and has proved the ability to perform satisfactory work

_____ h. Local board that generally regulates and enforces the plumbing code

1. Plumbing code
2. Zoning laws
3. Inspection
4. License
5. Plumbing inspector
6. Board of Health
7. Building code
8. BOCA Basic/National Plumbing Code

2. Discuss the membership of a plumbing code governing board, its authority, and its duties. Include at least eight points in your discussion.

____

____

____

____

____

____

3. Describe the benefits of zoning laws, building codes, and plumbing codes. Include at least six benefits in your discussion.

4. Select major categories that should be included in a plumbing code by placing an "X" in the appropriate blanks.

_______ a. Terms and definitions

_______ b. Design of water pipe, drainage, and vents

_______ c. Seasonal recommendations

_______ d. Types and quality of fixtures

_______ e. Plumbing legal issues

_______ f. Basic regulations

_______ g. Types and quality of joints

5. List six basic principles of plumbing codes.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

Written Test

6. Select true statements concerning illegal fittings and installations. Place an "X" in the blanks next to those statements which are true.

_______ a. A sanitary tee fitting should not be used to change direction from vertical to horizontal flow of drainage pipe.

_______ b. A single or double tee may be used in either vertical or horizontal drainage piping.

_______ c. A 90° bend should always have a radius of less than the diameter of the pipe.

_______ d. Double hub caulked fittings and pipes shall not be used except for vent lines.

_______ e. Fittings which reduce the flow in a drainage system are permitted.

_______ f. Traps should have an accessible cleanout or be able to be disassembled.

_______ g. A sanitary tee fitting in a vertical vent line should be inverted.

_______ h. Connections into the drainage system may be made with approved fittings or by drilling or tapping.

_______ i. A double sanitary tee should not be used if the outlet is the same size as the inlet.

_______ j. A sanitary tee fitting should not be used to change the direction of flow of horizontal drainage piping.

Permission to duplicate this test is granted.

Building and Plumbing Codes
Unit 4-C

Answers to Written Test

1.
   a. 7
   b. 1
   c. 5
   d. 2
   e. 3
   f. 8
   g. 4
   h. 6

2. Discussion should include at least eight of the following points:
   a. Membership
      - Member of the city board of health
      - Chief plumbing inspector
      - One or more master plumbers
      - One or more journeyman plumbers
   b. Administrative authority
      - State board
      - Local board
   c. Duties of the board might include:
      - Develop regulations which apply to local conditions for plumbing installations.
      - Develop amendments to the code on a regular basis.
      - Present the code and/or amendments to the city or town council for adoption into law.
      - Support the plumbing inspectors in their efforts to enforce the code.
      - Issue licenses and permits.
      - Take necessary steps to enforce the code.

3. Discussion should include at least six of the following points:
   a. Zoning laws
      - Regulate size and type of business or industry in specific geographical locations.
      - Separate residential areas from industrial areas.
      - Create business areas which make shopping more convenient.
      - Determine minimum building lot sizes and distance between buildings.
   b. Building codes
      - Determine the quality of construction in a community.
      - Protect public health, safety, and quality of life in a community.
   c. Plumbing codes
      - Protect the health of the community.
      - Regulate all construction whether industrial, business, or residential.
      - Permit grievances or complaints by the plumbing contractor to be reviewed by the board of health or the court.

4. a, b, d, f, g

5. Any six of the following:
   a. All premises intended for human habitation, occupancy, or use shall be provided with a supply of pure and wholesome water, neither connected with unsafe water supplies nor subject to the hazards of backflow.
   b. Plumbing fixtures and devices shall be supplied with water in sufficient volume and at pressures adequate to enable them to function satisfactorily and without undue noise under all normal conditions of use.
   c. Hot water shall be provided to fixtures which normally require hot water for their proper use.

d. Plumbing shall be designed and adjusted to use the minimum quantity of water consistent with proper performance and cleaning.
e. Devices for heating and storing water shall be designed and installed to guard against dangers from explosion or overheating.
f. Every building having plumbing fixtures installed and intended for human habitation, occupancy, or use on premises abutting on a street, alley, or easement in which there is a public water supply and sewer service shall have a connection with the water supply and sewer.
g. Each family dwelling unit shall have at least one water closet, one lavatory, one kitchen type sink, and one bathtub or shower to meet the basic requirements of sanitation and personal hygiene. All other structures for human occupancy or use shall be equipped with no less than one water closet and one lavatory.
h. Plumbing fixtures shall be made of durable, smooth, nonabsorbent, and corrosion-resistant material, and shall be free from concealed fouling surfaces.
i. The drainage system shall be designed, constructed, and maintained to guard against fouling, deposit of solids, and clogging, and with adequate cleanouts so arranged that the pipes may be readily cleaned.
j. The piping of the plumbing system shall be of durable material, free from defective workmanship, and so designed and constructed as to give satisfactory service for its reasonable expected life.
k. Each fixture directly connected to the drainage system shall be equipped with a liquid seal trap.
l. The drainage system shall be designed to provide an adequate circulation of air in all pipes with no danger of siphonage, aspiration, or forcing of trap seals under conditions of ordinary use.
m. Each vent terminal shall extend to the outer air and be installed to minimize the possibilities of clogging and the return of foul air to the building.
n. The plumbing system shall be subjected to such tests as will effectively disclose all leaks and defects in the work or the material.
o. No substance which will clog the pipes, produce explosive mixtures, destroy the pipes or their joints, or interfere unduly with the sewage-disposal process shall be allowed to enter the building drainage system.
p. Proper protection shall be provided to prevent contamination of food, water, sterile goods, and similar materials by backflow of sewage. When necessary, the fixture, device, or appliance shall be connected indirectly with the building drainage system.
q. No water closet, urinal, lavatory, bathtub, or shower shall be located in a room or compartment which is not properly lighted, heated, and ventilated.
r. If water closets or other plumbing fixtures are installed in buildings where there is no sewer, provision shall be made for disposing of the building sewage by an approved method of sewage treatment and disposal.
s. Where a plumbing drainage system may be subjected to backflow of sewage from the public sewer, provision shall be made to prevent its overflow in the building.
t. Plumbing systems shall be maintained in a safe and serviceable condition.
u. All plumbing fixtures shall be so installed with regard to spacing as to be accessible for their intended use and cleaning.
v. Plumbing shall be installed with due regard to preservation of the strength of structural members, and prevention of damage to walls and other surfaces through fixture usage.
w. Sewage or other waste shall not be discharged into surface or subsurface water unless it has first been subjected to an approved form of treatment.

6. a, d, f, g, i, j

Building and Plumbing Codes
Unit 4-C

Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Assignment Sheet Ratings

Assignment Sheet 1—Apply Code Regulations to a Plumbing Installation Rating ______

Comments: ______________________

____

Assignment Sheet 2—Use the BOCA Basic/National Plumbing Code Rating ______

Comments: ______________________

____

Written Test Scores

Pretest ______ Posttest ______ Other ______

Other ______________________

____

Teacher Signature ______________________ Date __________

Student Signature ______________________ Date __________

Permission to duplicate this form is granted.

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Metric Measurement for Plumbers
Unit 5-C

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  2—Convert English System Measurements to Metric Measurements C-125

Metric Measurement for Plumbers
Unit 5-C

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resources Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Make transparencies from the transparency masters included in this unit.
- Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

Unit Introduction

- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss the assignment sheets. Review with students the criteria for evaluation of these activities.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Discuss standard and metric measurement units (Student Supplement 1) and how plumbers use metric measurements. **(Mathematics; listening; speaking; systems interrelationships; and systems modification and design)**
- Discuss how other tradesworkers in the construction industry use metric measurements. **(Mathematics; listening; speaking; systems interrelationships; and systems modification and design)**
- Make a display of prefixes and their numerical values. **(Reading; mathematics; and information interpretation)**
- Explain that the metric system is easy to change from one metric unit to another simply by multiplying or dividing by multiples of ten. Refer to Teacher Supplement 1 to help illustrate the point. **(Listening; and mathematics)**
- Discuss the reasons that other countries worldwide use the metric system and why the United States has not converted. Include the advantages and disadvantages of converting in your discussion. **(Mathematics; listening; speaking; systems interrelationships; and systems modification and design)**
- Have the students practice measuring different lengths of pipe using both the metric and the standard English scale. **(Mathematics; and systems interrelationships)**
- Have the students calculate the actual length of pipe required for a variety of typical installations. **(Mathematics; and technology application)**
- Have the students practice calculating volumes for standard hot water tanks. **(Mathematics; and technology application)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.
- Make copies of the written test. Add or modify test items as needed.
- Give and evaluate written test.
- Compile assignment sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignments or supplemental activities that should be part of the unit evaluation.
- Meet individually with students to evaluate their progress through this unit of instruction and indicate to them possible areas of improvement.
- Reteach and retest as required.

Suggested Activities

Resources Used in Developing This Unit

- Barclay, Leney. *Residential Plumbing.* Revised by Hank Johnson. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1985.
- Blankenbaker, Keith E. *Modern Plumbing.* South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.

Suggested Supplemental Resources

- Massey, Howard C. *Plumber's Exam.* 5th ed. Carlsbad, CA: Craftsman Book Company, 1996.
- Massey, Howard C. *Plumber's Exam Preparation Guide.* 5th ed. Carlsbad, CA: Craftsman Book Company, 1996.
- Massey, Howard C. *Plumber's Handbook.* 5th ed. Carlsbad, CA: Craftsman Book Company, 1994.
- Charts, posters, pamphlets from:

  American National Metric Council
  1625 Massachusetts Ave. NW
  Washington, DC 20036
- Charts, publications, films, displays from:

  National Bureau of Standards
  Office of Information Activities
  US Department of Commerce
  Washington, DC 20234
- *Metric Practice Guide*, ASTM E 380-72e

  American Society for Testing and Materials
  1916 Race Street
  Philadelphia, PA 19103

Metric Measurement for Plumbers
Unit 5-C

Answers to Assignment Sheets

Assignment Sheet 1—Read U.S. Customary and Metric Rules

Part A

1. a. 1/4"
   b. 1/2"
   c. 1 1/4"
   d. 1 3/4"
   e. 1 1/4"
   f. 2 1/2"
   g. 1 1/4"
   h. 2 1/2"
   i. 1 1/2"
   j. 4"

2. a. 3/8"
   b. 1/4"
   c. 1 1/8"
   d. 3/4"
   e. 1 1/2"
   f. 2 3/4"
   g. 1/2"
   h. 2"
   i. 4 1/4"
   j. 2 3/8"

3. a. 15/16"
   b. 1/2"
   c. 1 13/16"
   d. 3/4"
   e. 1 11/16"
   f. 3 5/16"
   g. 1 1/2"
   h. 2 5/8"
   i. 4 1/4"
   j. 1 5/8"

4. a. 25/32"
   b. 1 5/32"
   c. 3/8"
   d. 1 27/32"
   e. 1 9/16"
   f. 1 1/2"
   g. 1 3/16"
   h. 2 13/16"
   i. 4 9/32"
   j. 1 15/16"

Part B

1. a. .08"
   b. .40"
   c. .58"
   d. .80"
   e. 1.28"
   f. .09"
   g. .38"
   h. .84"
   i. 1.07"
   j. 1.45"

2. a. .15"
   b. .50"
   c. 1.25"
   d. 1.80"
   e. 2.85"
   f. 3.95"
   g. 4.35"
   h. 4.95"
   i. 5.35"
   j. 5.85"

Part C

1. 5 mm
2. 20 mm
3. 37 mm
4. 49 mm
5. 73 mm
6. 6.5 mm
7. 17.5 mm
8. 30.5 mm
9. 50.5 mm
10. 69.5 mm

Answers to Assignment Sheets

Assignment Sheet 2—Convert English System Measurements to Metric Measurements

Part A

1. 31.750, 32
2. 50.80, 50
3. 114.3, 100
4. 152.40, 150
5. 12.70, 15
6. 203.20, 200

Part B

1. 38°C
2. 99°C
3. -23°C
4. -17.8°C
5. 18°C
6. -3.8°C

Part C

1. 2.8 liters
2. 9.5 liters
3. 14.1 liters
4. 15.1 liters
5. 37.9 liters
6. 45.4 liters

Part D

1. 11 kg
2. 43 kg
3. 113 kg
4. 2 kg
5. 20 kg
6. 54 kg

Part E

1. 18 sq. ft.
2. 36 cu. ft.
3. 2304 cu. in.
4. 12.6 sq. ft.
5. 50.2 cu. ft.
6. 401.9 cu. ft.

Part F

1. 37.4 gal.
2. 104.7 gal.
3. 201.96 gal.
4. 0.05 gal.
5. 0.12 gal.
6. 0.16 gal.

Part G

1. 50 mm
2. 3.048 m
3. 7.2°C
4. 7.57 l
5. 11.35 kg
6. 1.89 l
7. 12.7 mm or 15 mm
8. 23.88°C

Metric Measurement for Plumbers
Unit 5-C

Written Test

Name ______________________ Date ____________ Score ____________

1. Match the terms on the right with the correct definitions.

_______ a. System currently used in the United States; measurements are in inches, feet, and yards; pounds and ounces; and temperature is measured in Fahrenheit degrees

_______ b. System used in most of the world; measurements are in meters, grams, liters, and Celsius degrees

_______ c. International System of Units; modern version of the metric system

_______ d. Referring to the metric system as being divisible into ten parts

_______ e. Word adopted by the metric system for weight

_______ f. Referring to lines or the measurement of lines

_______ g. The volume water reaches at 39.2°F

_______ h. A measurement of the surface included within a two-dimensional set of lines

_______ i. The amount of space occupied by a three-dimensional object

1. Metric system
2. Volume
3. SI
4. English system
5. Mass
6. Maximum density of water
7. 10th multiple
8. Area
9. Linear

2. Write the abbreviations for the following common metric measurements in the blanks provided.

a. _______ Celsius degree

b. _______ Gram

c. _______ Milliliter

d. _______ Centimeter

e. _______ Fahrenheit degree

f. _______ Liter

g. _______ Millimeter

h. _______ Meter

3. Convert approximate pipe sizes and lengths from the English system to the metric system. Write the correct answers in the blanks provided.

a. 1″ diameter pipe = ____________ mm = ____________ mm pipe

b. 1 1/2″ diameter pipe = ____________ mm = ____________ mm pipe

c. 2″ diameter pipe = ____________ mm = ____________ mm pipe

d. 10″ length = ____________________ centimeters

e. 100″ length = ____________________ centimeters

f. 12″ = ____________________ centimeters

g. 16″ = ____________________ centimeters

4. Convert temperature measurements from the English system to the metric system. Write the correct answers in the blanks provided.

a. 32°F = ____________ °C

b. 39.2°F = ____________ °C

c. 98.6°F = ____________ °C

d. 212°F = ____________ °C

e. 75°F = ____________ °C

f. 60°F = ____________ °C

g. 90°F = ____________ °C

h. 50°F = ____________ °C

5. Convert liquid measurement from the English system to the metric system. Write the correct answers in the blanks provided.

a. 30-gallon water heater = ____________________

b. 40-gallon water heater = ____________________

c. 60-gallon water heater = ____________________

d. 6 gallons = ______________ liters

e. 2 quarts = ______________ liters

f. 4 pints = ______________ liters

g. 8 quarts = ______________ liters

6. Convert weight (mass) measurements from the English system to the metric system. Write the correct answers in the blanks provided. Round to the nearest whole number.

a. 22 lb. wall hung lavatory = ____________________

b. 88 lb. water closet = ____________________

c. 154 lb. cast iron bathtub = ____________________

Written Test

7. Calculate the volumes of the rectangular and cylindrical tanks described below. Write the correct answers in the blanks provided.

   a. A rectangular tank that measures 10′ long by 4′ wide by 10′ tall:

   ____

   b. A rectangular tank that measures 5′ long by 3′ wide by 6′ tall:

   ____

   c. A cylindrical tank that measures 2′ in diameter and 5′ tall:

   ____

   d. A cylindrical tank that measures 8′ at the base and stands 15′ tall:

   ____

8. Convert cubic feet and inches to gallons. Write the correct answers in the blanks provided.

   a. A rectangular tank that is 7′ long, 4′ wide, and 8′ high will hold __________ gallons.

   b. A cylindrical tank that measures 6′ at the base and 8′ tall will hold ________ gallons.

   c. 5000 cubic inches = ______________ gallons.

Permission to duplicate this test is granted.

Metric Measurement for Plumbers
Unit 5-C

Answers to Written Test

1. a. 4
   b. 1
   c. 3
   d. 7
   e. 5
   f. 9
   g. 6
   h. 8
   i. 2

2. a. C°
   b. g
   c. ml
   d. cm
   e. F°
   f. l
   g. mm
   h. m

3. a. 25.40 mm = 25 mm pipe
   b. 38.1 mm = 38 mm pipe
   c. 50.8 mm = 50 mm pipe
   d. 25.4 cm
   e. 254 cm
   f. 30.48 cm
   g. 40.64 cm

4. a. 0°C
   b. 4°C
   c. 37°C
   d. 100°C
   e. 23.8°C
   f. 15.5°C
   g. 32.2°C
   h. 10°C

5. a. 113.55 liters
   b. 151.4 liters
   c. 227.1 liters
   d. 22.71 liters
   e. 1.89 liters
   f. 1.892 liters
   g. 7.57 liters

6. a. 10 kg
   b. 40 kg
   c. 70 kg

7. a. 400 cubic feet
   b. 90 cubic feet
   c. 15.7 cubic feet
   d. 753.6 cubic feet

8. a. 1675.5 gallons
   b. 1691.1 gallons
   c. 21.6 gallons

Metric Measurement for Plumbers
Unit 5-C

Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Assignment Sheet Ratings

Assignment Sheet 1—Read U.S. Customary and Metric Rules Rating ________

Comments: ____

____

Assignment Sheet 2—Convert English System Measurements to Metric Measurements Rating ________

Comments: ____

____

Written Test Scores

Pretest __________ Posttest __________ Other __________

Other ____

____

Teacher Signature ______________________ Date ______________

Student Signature ______________________ Date ______________

Permission to duplicate this form is granted.

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Metric Measurement for Plumbers
Unit 5-C

Teacher Supplement 1—Converting From One Metric Unit to Another

In the U.S. customary system of measurement, conversions from one unit to another are difficult because the units are so different. There are 5280 feet in a mile, 16 ounces in a pound, 2 cups in a pint, and 36 inches in a yard. Also, the units of measure are not easily related to each other. *One* gallon of water, for instance, weighs 8.345 pounds. In the metric system, however, the measurement units are all powers of ten, and units are all easily related to each other. *One* liter of water, for instance, weighs *one* kilogram.

To convert from one metric unit to another, divide by 10, 100, 1000, etc. Because these conversion factors are all powers of 10, you can simply move the decimal point to the right or left instead of actually dividing or multiplying. Use the diagrams below to help you convert from one metric unit to another.

$$\mathrm{km} \xleftrightarrow{\;3\;} \mathrm{m} \xleftrightarrow{\;2\;} \mathrm{cm} \xleftrightarrow{\;1\;} \mathrm{mm}$$

Examples: To change meters to centimeters, move the decimal point two places to the right: 5.2 m = 520 cm.

To change millimeters to meters, move the decimal point 1 + 2, or 3 places to the left: 63 mm = .063 m.

$$\mathrm{kl} \xleftrightarrow{\;3\;} \mathrm{l} \xleftrightarrow{\;2\;} \mathrm{cl} \xleftrightarrow{\;1\;} \mathrm{ml}$$

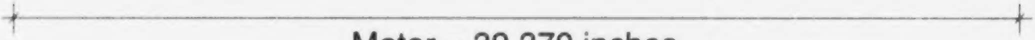
Examples: To change liters to kiloliters, move the decimal point 3 places to the left: 560 l = .56 kl.

To change liters to milliliters, move the decimal point 2 + 1, or 3 places to the right: 7.6 l = 7600 ml.

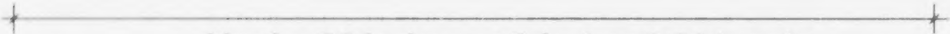
Permission to duplicate this supplement is granted.

Relative Lengths of Metric and Standard Units

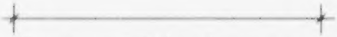
Note: Measurements are not actual size.



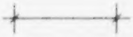
Meter = 39.370 inches



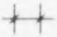
Yard = 36 inches or 3 feet or 0.914 meter



Foot = 12 inches or 1/3 yard or 0.305 meter



Decimeter = 3.97 inches



Inch = 0.083 foot or 25.40 miliimeters or 2.54 centimeters

Centimeter = 0.39 inches

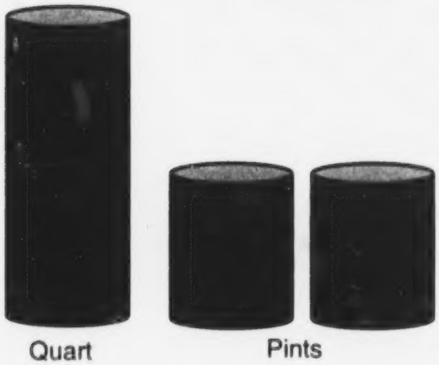
Millimeter = 0.04 inches

Note: In relative terms, the millimeter would be no larger than a dot on this page; therefore, no representation is shown.

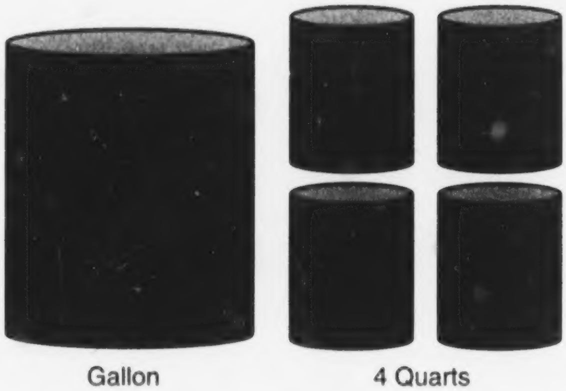
Liquid Measurement

1 fluid ounce = 1.804 cubic inches = 29.573 milliliters

1 pint or 16 fluid ounces = 28.875 cubic inches = 0.473 liter

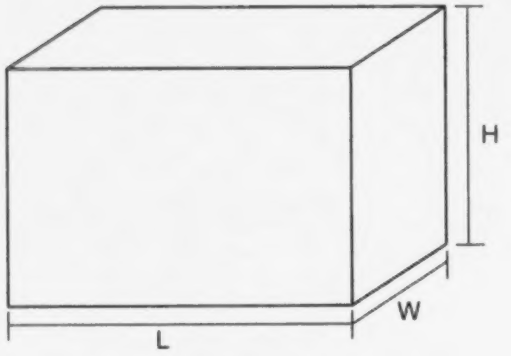


1 quart or 2 pints = 57.75 cubic inches = .0946 liter

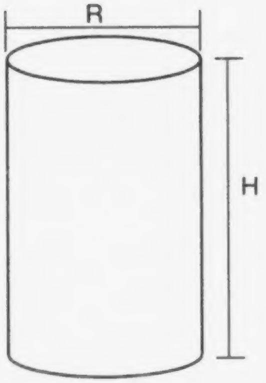


1 gallon or 4 quarts = 231 cubic inches
= 3.785 liters

Volume Calculations



Volume of rectangular tank
V = Length (L) x Width (W) x Height (H)
$V = LWH$



Volume of cylindrical tank
V = Area (Πr^{2}) x Height (H)
$V = \Pi r^{2} H$

Drainage Systems
Unit 1-D

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Drainage Systems
Unit 1-D

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resources Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Make transparencies from the transparency masters included in this unit.
- Review "Instructions for Evaluating Student Performance."
- Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

Unit Introduction

- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss the assignment sheets. Review with students the criteria for evaluation of these activities.
- Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and materials are available. Review criteria for evaluation of these activities.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000.* These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Provide students with drawings of drainage systems and have them identify the soil, waste, and vent pipes. **(Seeing things in the mind's eye)**
- Conduct a field trip to a construction site while plumbers are installing various parts of the drainage system. **(Listening; and knowing how to learn)**
- Have students read the local plumbing code book for specific local requirements on the drainage system. **(Reading; reasoning; and interpretation)**
- Provide examples of different materials used for soil and waste pipes. **(Listening; and material selection)**
- Demonstrate the procedure for testing a drainage system for leaks using either the water or air method. **(Listening; and technology application)**
- Discuss variations on the job sheets that would be acceptable using other materials, such as the procedure for installing a shower with plastic pipe and epoxy as a variation on Job Sheet 2. **(Listening; reasoning; and material selection)**
- Stress the importance of following all safety precautions while trenching by relating personal experiences to the students or by using other available teaching methods and aids. **(Listening; and responsibility)**
- Invite a county health department representative to discuss with the class the importance of proper installation and maintenance of drainage systems. **(Listening; reasoning; and responsibility)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.
- Make copies of the written test. Add or modify test items as needed.
- Give and evaluate written test.
- Compile the assignment sheet ratings, job sheet ratings, and written test score on the Unit Evaluation Form. Include any additional assignments or supplemental activities that should be part of the unit evaluation.
- Meet individually with students to evaluate their progress through this unit of instruction and indicate to them possible areas of improvement.
- Reteach and retest as required.

Suggested Activities

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

Resources Used in Developing This Unit

- Barclay, Leney. *Residential Plumbing*. Revised by Hank Johnson. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1985.

- Blankenbaker, Keith E. *Modern Plumbing*. South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.

Suggested Supplemental Resources

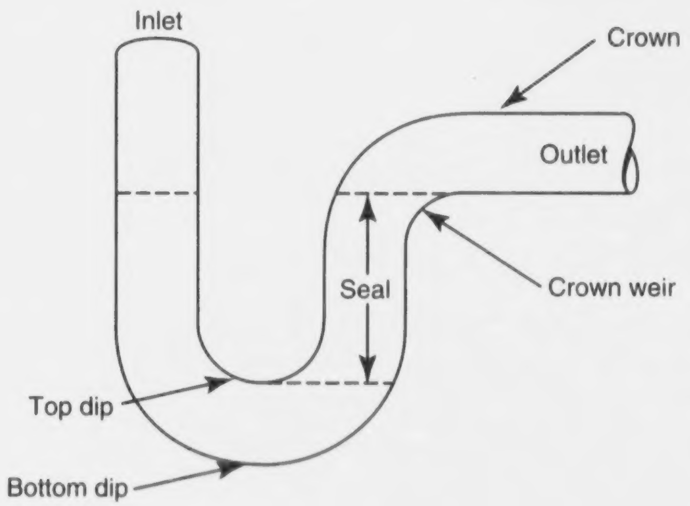
- Massey, Howard C. *Plumber's Exam*. 5th ed. Carlsbad, CA: Craftsman Book Company, 1996.

- Massey, Howard C. *Plumber's Handbook*. 5th ed. Carlsbad, CA: Craftsman Book Company, 1994.

Drainage Systems
Unit 1-D

Answers to Assignment Sheets

Assignment Sheet 1—Label a Cross Section of a P-Trap



Assignment Sheet 2—Identify Fittings on a Drainage System

A. Tub waste and overflow
B. P-trap
C. Cleanout
D. Combination Y and 1/8 bend
E. Sanitary tee with 1 1/2″ tap
F. Closet bend
G. Closet flange
H. Stack vent
I. Sanitary tee with 1 1/2″ tap
J. Waste pipe
K. 90° ell
L. P-trap

Drainage Systems
Unit 1-D

Written Test

Name ______________________________ Date ____________ Score ____________

1. Match the terms on the right with their definitions.

_______ a. Drain, waste, and vent

_______ b. Slope or grade given to a horizontal run of pipe to permit gravity flow of liquid

_______ c. Pipe which carries waste water

_______ d. Access point to drain or trap for the purpose of removing obstructions

_______ e. Shield that fits over vent pipe on roof to prevent water from entering house through roof opening

_______ f. Creating a partial vacuum in a pipe so that water can be drawn into it

_______ g. Pipe which connects water closets to building drain and extends up and out of house to serve as a vent

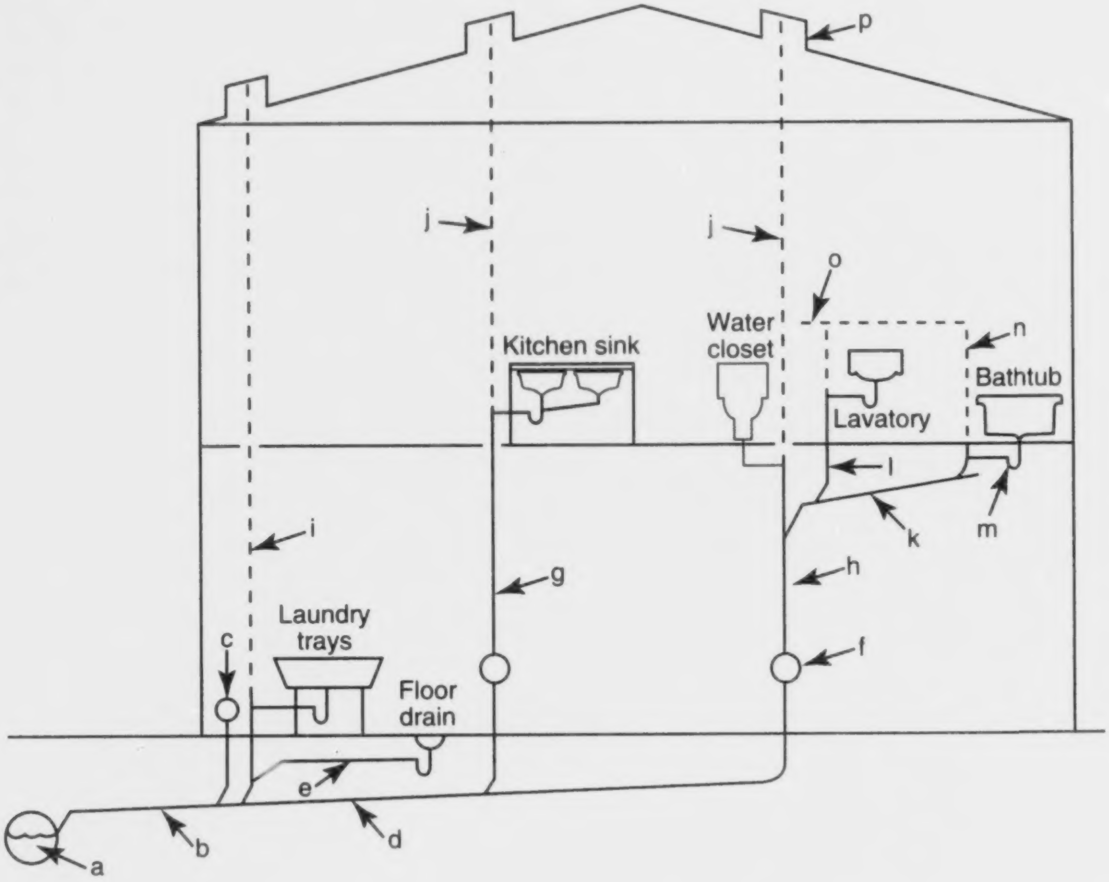
_______ h. Initial stages of plumbing installation which include bringing the water and sewer lines into the building and topping out or installing all pipes which will be enclosed in the walls

_______ i. The vertical extension of the drainage system through the roof and all that piping above the highest horizontal drain is connected to the stack

1. Flashing
2. Pitch
3. Rough-in
4. Soil stack
5. Siphoning
6. DWV
7. Vent stack
8. Cleanout
9. Drain pipe

Written Test

2. Identify soil, waste, and vent pipes in a drainage system. Write the correct answers in the blanks provided.



a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

h. ______________________________

i. ______________________________

j. ______________________________

k. ______________________________

l. ______________________________

m. ______________________________

n. ______________________________

o. ______________________________

p. ______________________________

Written Test

3. Distinguish between materials used in soil pipes and materials used in waste pipes. Place an "X" next to the materials used for soil pipes and an "O" next to the materials used for waste pipes. Some materials may be used for both types of pipes.

_______ a. Cast iron

_______ b. Copper

_______ c. Plastic

_______ d. Galvanized steel

4. State the functions of soil, waste, and vent pipes in a drainage system. Write the answers in the blanks provided.

a. Soil pipes ____

____

b. Waste pipes ____

____

c. Vent pipes ____

____

5. State two purposes of plumbing traps.

a. ____

b. ____

6. Select types of traps by placing an "X" in the appropriate blanks.

_______ a. P-trap

_______ b. T-trap

_______ c. A-trap

_______ d. S-trap

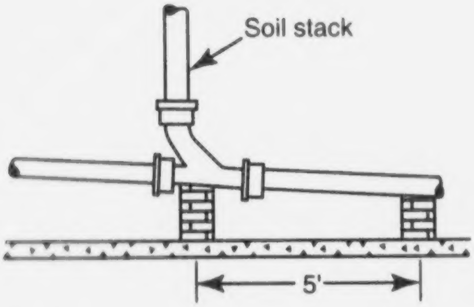
_______ e. Running trap

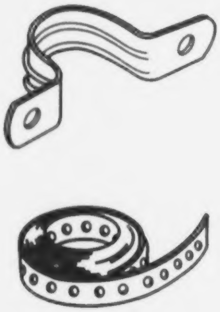
_______ f. Gun trap

_______ g. Drum trap

Written Test

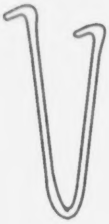
7. Identify the following various types of pipe hangers, clamps, and supports.

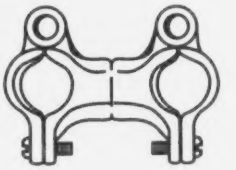




a. ______________________________

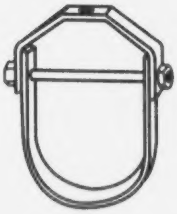
b. ______________________________

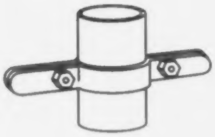




c. ______________________________

d. ______________________________





e. ______________________________

f. ______________________________

Written Test

8. Match pipe hangers, clamps, and supports on the right with their uses.

_______ a. Supports base of stack and horizontal runs of large pipe near floor or ground level

_______ b. Supports small size pipes by attaching to walls, beams, and ceilings

_______ c. Supports small to medium size pipes to wooden beams and joists

_______ d. Supports small to medium size pipes to any kind of ceiling or wall structure

_______ e. Supports medium to large size pipes to ceiling or wall structure

_______ f. Supports stacks and other large pipe when additional vertical support is needed

1. Pipe hook
2. Clevis hanger
3. Pipe clamp
4. Pier
5. Riser clamp
6. Strap

9. Distinguish between the location, materials, and functions of building sewers and storm drains by placing an "X" next to items related to storm drains.

_______ a. Located between building and sewer main

_______ b. Made from cast iron, vitrified clay, plastic, or galvanized steel

_______ c. Carry sewage from the building to the main sewer

_______ d. Carry off rain water and other uncontaminated water in a system independent of the sewage system

_______ e. Located in, under, and/or outside building

10. Select true statements concerning the installation of building sewers and storm drains by placing an "X" next to the the true statements.

_______ a. Excavation of trench for building sewers should be neat and clean.

_______ b. Building sewer trenches do not require any pitch.

_______ c. When a "lateral" is provided by the city for a building sewer, the plumber must establish the actual depth of this lateral.

_______ d. Storm drains are usually trapped.

_______ e. Drain pipe might empty into the street.

_______ f. Drain pipes around foundations are perforated to collect and carry seepage water away from building.

Written Test

11. List two steps used when adding new plumbing to an old system during each of the following stages.

    a. Planning

       1) ______________________________

       2) ______________________________

    b. Roughing-in the drainage

       1) ______________________________

       2) ______________________________

    c. Roughing-in water distribution pipes

       1) ______________________________

       2) ______________________________

12. Select true statements concerning the water and air methods of testing drainage systems for leaks by placing an "X" next to the true statements.

_______ a. For the water method, the system must be filled until water overflows the vent stack above the roof if the entire system is being tested.

_______ b. For the water method, a 2″ head must be applied to the tested section if only that section is being tested.

_______ c. For the water method, the water must remain in the system 24 hours prior to the test.

_______ d. For the water method, all joints of the tested system are visually inspected

_______ e. For the air method, all inlets and outlets must be closed.

_______ f. For the air method, the system is tested by maintaining 5 psi pressure for 15 minutes.

13. Complete the following statements concerning trenching techniques by filling in the blanks with the correct answers.

    a. Open trenching is acceptable only when _______________ type and space permit a safe angle of _______________.

    b. Federal standards require shored trenching where excavation walls exceed a depth of _______________ feet, and trenches must have a _____________ for every 25 feet of lateral.

Written Test

14. Match shoring materials and devices on the right with the correct definitions.

______ a. Wooden stanchions placed at intervals and supported by wooden braces

______ b. Continuous, tightly arranged wooden stanchions held by wooden cross members

______ c. A pile or sheeting that forms a continuous support wall, or a row of timber, concrete, or steel piling driven to assure a tight supporting wall against earth pressure

______ d. A continuous supportive box of wood and/or metallic supports to retain the earth

______ e. Hydraulic jacks, usually made of aluminum, activated by a hydraulic pump

______ f. Metallic screw devices with foot supports on both edges; they hold timbers or boards against the trench face

1. Trench box
2. Screw jacks
3. Light timber sheeting
4. Hydraulic shores
5. Timber bracing
6. Sheet piling

15. List two safety precautions for each of the various trenching hazards listed.

a. Materials and tools falling into the trench

1) ______________________________

2) ______________________________

b. Excavated debris falling into the trench

1) ______________________________

2) ______________________________

c. Machinery falling into an excavation

1) ______________________________

2) ______________________________

d. People falling into an open trench

1) ______________________________

2) ______________________________

Permission to duplicate this test is granted.

Drainage Systems
Unit 1-D

Answers to Written Test

1. a. 6
   b. 2
   c. 9
   d. 8
   e. 1
   f. 5
   g. 4
   h. 3
   i. 7

2. a. City sewer
   b. Building sewer
   c. Cleanout
   d. Building drain (soil pipe)
   e. Building drain branch (waste pipe)
   f. Stack cleanout
   g. Waste stack (waste pipe)
   h. Soil stack (soil pipe)
   i. Vent stack (vent pipe)
   j. Stack vent (vent pipe)
   k. Horizontal branch (waste pipe)
   l. Fixture drain (waste pipe)
   m. Fixture trap
   n. Individual vent (vent pipe)
   o. Branch vent
   p. Roof flashing

3. a. X O
   b. X O
   c. X O
   d. O

4. a. Soil pipes carry drainage which includes fecal matter.
   b. Waste pipes carry liquid waste which does not contain fecal matter.
   c. Any of the following for vent pipes:
      1) Allow free air to circulate in the system as the "vent" or terminal is open to the atmosphere above the building roof
      2) Provide equalization of air pressure on both sides of the fixture trap, thus preventing the siphoning of the trap
      3) Minimize back pressure on trap seals, thus preventing loss of seal

5. Any two of the following:
   a. Provide a liquid seal which will prevent the back passage of air without affecting the flow of sewage or waste water through it
   b. Prevent sewer gas from entering the building through the fixture
   c. Prevent vermin from entering the building through the fixture

6. a, d, e, g

7. a. Pier
   b. Straps
   c. Pipe hook
   d. Pipe clamp
   e. Clevis hanger
   f. Riser clamp

Answers to Written Test

8. a. 4
   b. 6
   c. 1
   d. 3
   e. 2
   f. 5

9. b, d, e

10. a, c, f

11. Any two under each stage:
    a. Planning
       1) Check local plumbing code.
       2) Determine location and design.
       3) Determine availability of existing plumbing.
       4) Develop materials list.
    b. Roughing-in the drainage
       1) Determine layout of new fixtures.
       2) Cut out access holes and openings for new pipe installation.
       3) Cut into the existing drainage system.
       4) Install drainage pipes.
    c. Roughing-in water distribution pipes
       1) Cut into existing water system.
       2) Cut and/or drill access holes and openings for new pipe installation.
       3) Install water distribution pipes.

12. a, d, e, f

13. a. Soil, repose
    b. Four, ladder

14. a. 5
    b. 3
    c. 6
    d. 1
    e. 4
    f. 2

15. Any two of the following for each:
    a. Materials and tools falling into the trench
       - Place all pipes or tools used on the job at least two feet from the edge of a trench.
       - All workers should wear hard hats to protect themselves from devices or tools accidentally dropped in the trench.
       - Hand pipe carefully into a trench; do not drop or roll it.
       - Two or more workers should handle heavy tools and pipe to avoid their getting out of control.
       - Move pipe and equipment only as required.
       - Never stack materials by the edge of a trench or any excavation.
    b. Excavated debris falling into the trench
       - Place earth, rocks, or other materials removed from the trench at least two feet from the edge.
       - Avoid piling excavated materials too high since this could overload the trench wall and create a potential cave in.

Answers to Written Test

c. Machinery falling into an excavation
  - Beware of operating equipment at all times and maintain a safe distance.
  - If operating equipment vibrates excessively, notify a foreman; this vibration could be transmitted through soil to the trench wall and cause a cave in.
  - Note any careless or unskilled machine operators and ask the appropriate foreman to correct the situation.

d. People falling into an open trench
  - Secure the job site at all times, especially at night, keeping in mind that curious children see job sites as interesting playgrounds.
  - Cover all open trenches with timber or plywood strong enough to support a reasonable amount of weight.
  - Position the protective sheathing so it will not only protect the public from danger but also shield the trench from rain water.
  - Reflective barricades and lights around the trench add additional protection for both curious passersby and animals.

Drainage Systems
Unit 1-D

Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Assignment Sheet Ratings

Assignment Sheet 1—Label a Cross Section of a P-Trap Rating ______

Comments: ______________________________________

____

Assignment Sheet 2—Identify Fittings on a Drainage System Rating ______

Comments: ______________________________________

____

Assignment Sheet 3—Secure a Permit for the Installation of a Plumbing System Rating ______

Comments: ______________________________________

____

Job Sheet Ratings

Job Sheet 1—Install a Bathtub Waste and Overflow and Trap on a Two-Story Building Rating ______

Comments: ______________________________________

____

Job Sheet 2—Install a Prefabricated Shower Base Drain (Caulked Method) Rating ______

Comments: ______________________________________

____

Job Sheet 3—Lay Out Trench Lines Rating ______

Comments: ______________________________________

____

Unit Evaluation Form

Job Sheet 4—Calculate the Slope Required for Building Sewer Lines Rating ________

Comments: ______________________________

____

Job Sheet 5—Install Drain Pipe in Trenches Rating ________

Comments: ______________________________

____

Job Sheet 6—Install Storm Drains Rating ________

Comments: ______________________________

____

Job Sheet 7—Backfill Trenches Rating ________

Comments: ______________________________

____

Job Sheet 8—Install Pipe Sleeves or Thimbles Through Walls, Ceilings, or Floors Rating ________

Comments: ______________________________

____

Job Sheet 9—Install Soil or Waste Back Vents Rating ________

Comments: ______________________________

____

Job Sheet 10—Install Cleanouts on Drains Rating ________

Comments: ______________________________

____

Job Sheet 11—Rough-In Waste Lines and Vents for Built-In Lavatories Rating ________

Comments: ______________________________

____

Unit Evaluation Form

Job Sheet 12—Rough-In Waste Lines and Vents for Bathtubs Rating ________

Comments: ____

____

Job Sheet 13—Secure Horizontal and Vertical Lines of Pipe to Masonry Surfaces With Hangers Rating ________

Comments: ____

____

Job Sheet 14—Secure Horizontal and Vertical Lines of Pipe to Wood Surfaces With Hangers Rating ________

Comments: ____

____

Job Sheet 15—Secure Horizontal and Vertical Lines of Pipe to Metal Surfaces With Hangers Rating ________

Comments: ____

____

Job Sheet 16—Install Vent Terminals (Roof Flashing) Rating ________

Comments: ____

____

Job Sheet 17—Inspect a Plumbing System Rating ________

Comments: ____

____

Written Test Scores

Pretest ________ Posttest ________ Other ________

Other ____

____

Teacher Signature ____________________ Date ____________

Student Signature ____________________ Date ____________

Permission to duplicate this form is granted.

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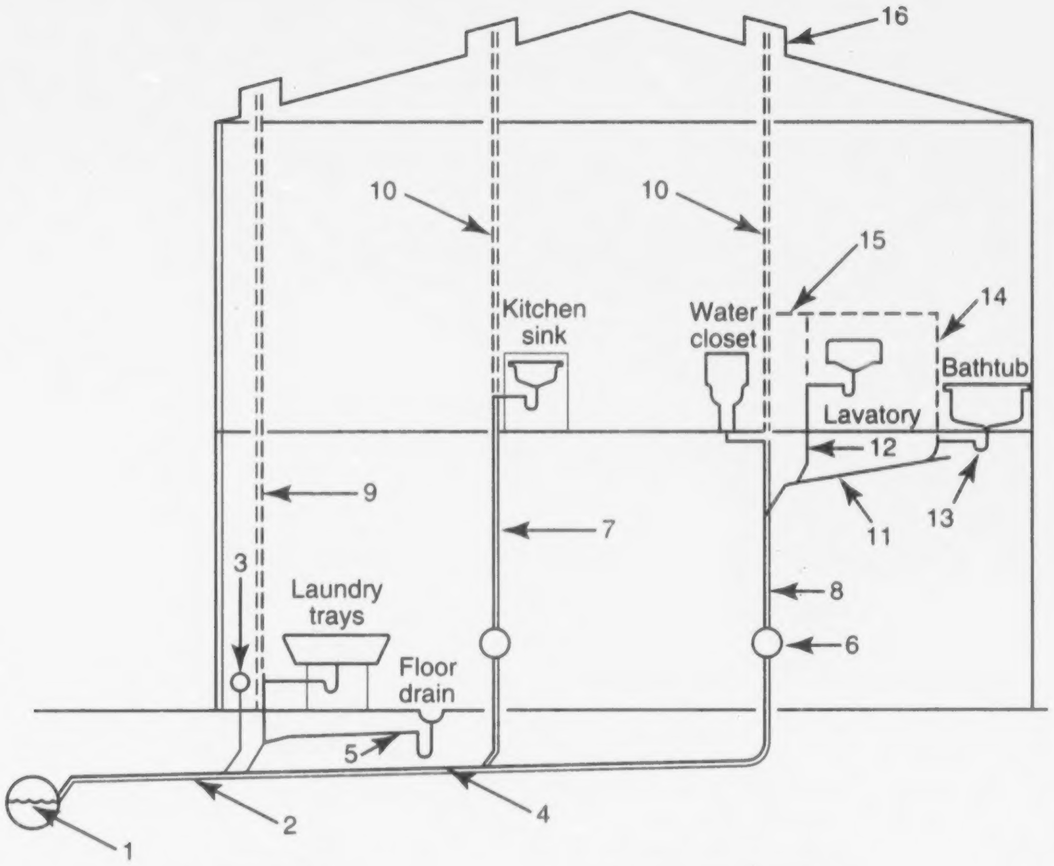
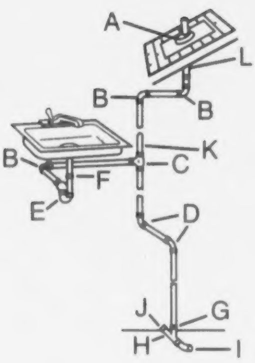
Soil, Waste, and Vent Pipes



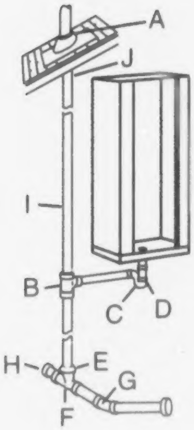
1. City Sewer
2. Building Sewer
3. Cleanout
4. Building Drain (Soil pipe)
5. Building Drain Branch (Waste pipe)
6. Stack Cleanout
7. Waste Stack (Waste pipe)
8. Soil Stack (Soil pipe)
9. Vent Stack (Vent pipe)
10. Stack Vent (Vent pipe)
11. Horizontal Branch (Waste pipe)
12. Fixture Drain (Waste pipe)
13. Fixture Trap
14. Individual Vent (Vent pipe)
15. Branch Vent (Vent pipe)
16. Roof Flashing

Soil, Waste, and Vent Pipes
(Continued)



Kitchen Sink Only

CODE	DESCRIPTION	SIZE	QTY
A	Roof Flashing	1 1/2″	1
B	90° Elbows	1 1/2″	3
C	Sanitary Tee	1 1/2″	1
D	45° Elbows	1 1/2″	2
E	"P" Trap	1 1/2″	1
F	Trap Adapter	1 1/2″	1
G	PVC Bushing	2″ x 1 1/2″	1
H	PVC Sch. 40 "Y" Branch	2″	1
I	PVC Sch. 40 1/8″ Bend	2″	1
J	Cleanout Ferrule	2″	1
K	Plastic Pipe—PVC Sch. 40	1 1/2″	20 Ft.
L	Plastic Pipe	2″	10 Ft.

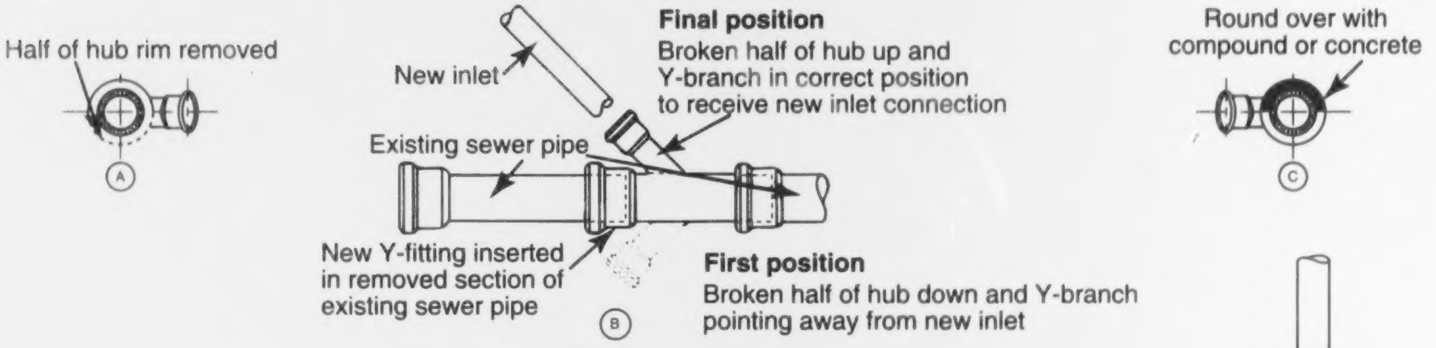


Shower Only

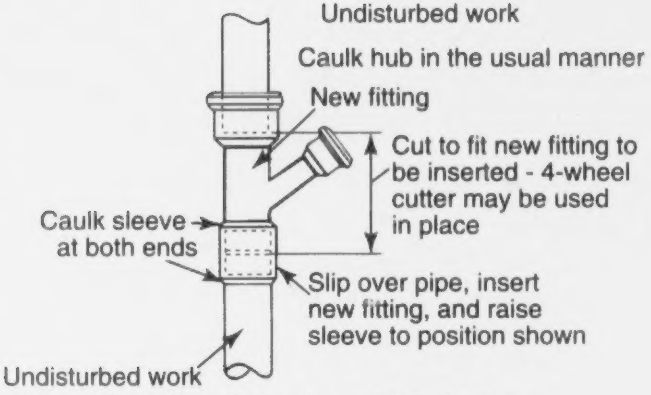
CODE	DESCRIPTION	SIZE	QTY
A	Roof Flashing	2″	1
B	Sanitary Tee	1 1/2″	1
C	"P" Trap	1 1/2″	1
D	Trap Adapter	1 1/2″	1
E	Plastic Bushing	1 1/2″	1
F	PVC Sch. 40 "Y" Branch	2	1
G	PVC Sch. 40 1/8″ Bend	2″	1
H	Cleanout Ferrule	2″	1
I	Plastic Pipe	1 1/2″	20 Ft.
J	Plastic Pipe	2″	10 Ft.

Adding New Plumbing to an Old System

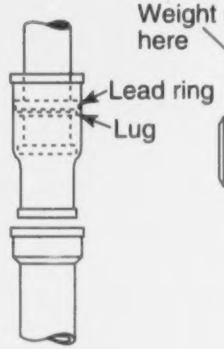
(Refer to Local Codes)

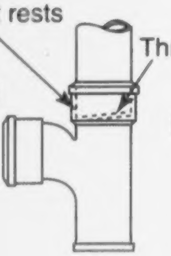

Half of hub rim removed
A
New inlet
Final position
Broken half of hub up and Y-branch in correct position to receive new inlet connection
Existing sewer pipe
New Y-fitting inserted in removed section of existing sewer pipe
B
First position
Broken half of hub down and Y-branch pointing away from new inlet
Round over with compound or concrete
C

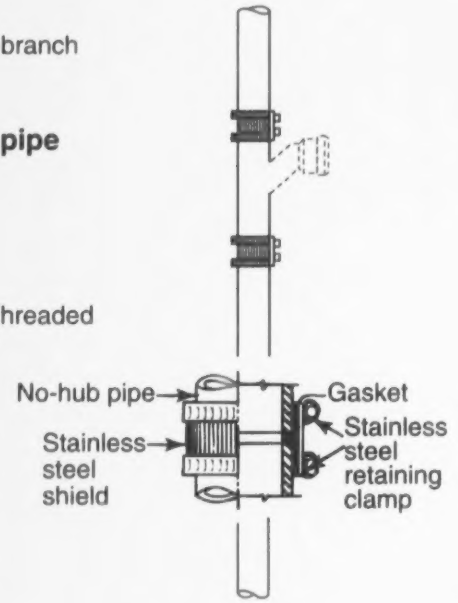
Adding connections to outside vitrified clay sewer pipe


Undisturbed work
Caulk hub in the usual manner
New fitting
Cut to fit new fitting to be inserted - 4-wheel cutter may be used in place
Caulk sleeve at both ends
Slip over pipe, insert new fitting, and raise sleeve to position shown
Undisturbed work

Installing fitting in restricted space



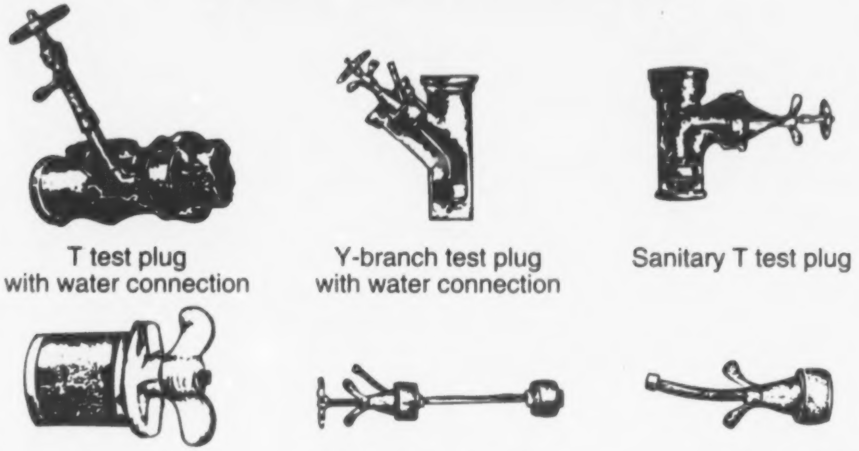




Cutting into the Existing Drainage System

Testing for Leaks

(Refer to Local Codes)



T test plug with water connection

Y-branch test plug with water connection

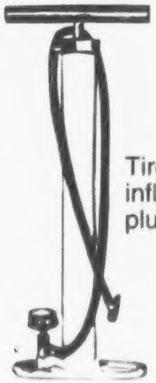
Sanitary T test plug

Short pattern test plug

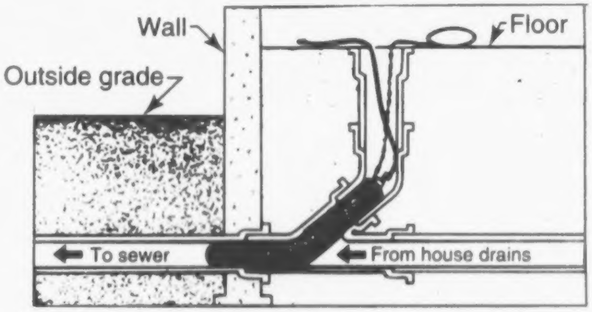
Double straight test T

Single straight test T

A variety of test plugs may be used to seal openings in the piping so that tests can be conducted. (Courtesy of Cherne Industries)



Tire pump for inflating test plug and balls



Long inflatable rubber test plug being used to seal the building drain at the front main cleanout opening. (Courtesy of Cherne Industries)

Water Systems
Unit 2-D

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Assignment Sheets
  1—Make an Isometric Drawing of a Hot and Cold Water System for a Two-Story House D-65
  2—Determine Pipe Sizes for a Hot and Cold Water System for a Two-Story House D-67
Job Sheets
  1—Rough-In Water Supply Lines for Bathtubs D-69
  2—Rough-In Water Supply Lines for a Water Closet D-71
  3—Rough-In Water Supply Lines for a Water Heater D-73
  4—Make Water Pressure Tests on Water Supply Systems D-75

Water Systems
Unit 2-D

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resources Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Make a transparency from the transparency master included in this unit.
- Review "Instructions for Evaluating Student Performance."
- Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

Unit Introduction

- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss the assignment sheets. Review with students the criteria for evaluation of these activities.
- Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and materials are available. Review criteria for evaluation of these activities.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Provide students with additional drawings of water systems and have them identify the various components. **(Seeing things in the mind's eye)**
- Conduct a field trip to a construction site where plumbers are installing various parts of the water system. **(Listening; and knowing how to learn)**
- Have the students read the local plumbing code book for specific local requirements on the water system. **(Reading; reasoning; and interpretation)**
- Provide examples of different materials used for pipes and valves used in water pipe systems. **(Listening; and selection)**
- Demonstrate the procedure for testing a water system for leaks using either the water or air method. **(Listening; and application)**
- Visit a plumbing supply company with the students to learn about low-flow fixtures, shower heads, and faucets. **(Listening; material and facilities; and selection)**
- Have the students research and compare water heaters. Have them obtain information such as size of storage, fuel type, recovery rate, and estimated energy cost. **(Reading; mathematics; decision making; reasoning; money; material and facilities; information acquisition and evaluation and interpretation; and selection)**
- Have the students do an experiment to show how much water can be wasted by a dripping faucet. Place a measuring cup under a dripping faucet, record how much water has collected in 1/2 hour. Have the students repeat this procedure every 1/2 hour for 4 hours, and then estimate the volume of water wasted in 24 hours. **(Mathematics; science; and problem solving)**
- Have the students obtain information about solar water heating equipment, and discuss pros and cons of solar water heating in class. **(Reading; listening; speaking; reasoning; and learning how to learn)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.
- Make copies of the written test. Add or modify test items as needed.
- Give and evaluate written test.
- Compile the assignment sheet ratings, job sheet ratings, and written test scores on the Unit Evaluation Form. Include any additional assignments or supplemental activities that should be part of the unit evaluation.

Suggested Activities

- Meet individually with students to evaluate their progress through this unit of instruction and indicate to them possible areas of improvement.
- Reteach and retest as required.

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

Resources Used in Developing This Unit

- Barclay, Leney. *Residential Plumbing.* Revised by Hank Johnson. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1985.
- Blankenbaker, Keith E. *Modern Plumbing.* South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.

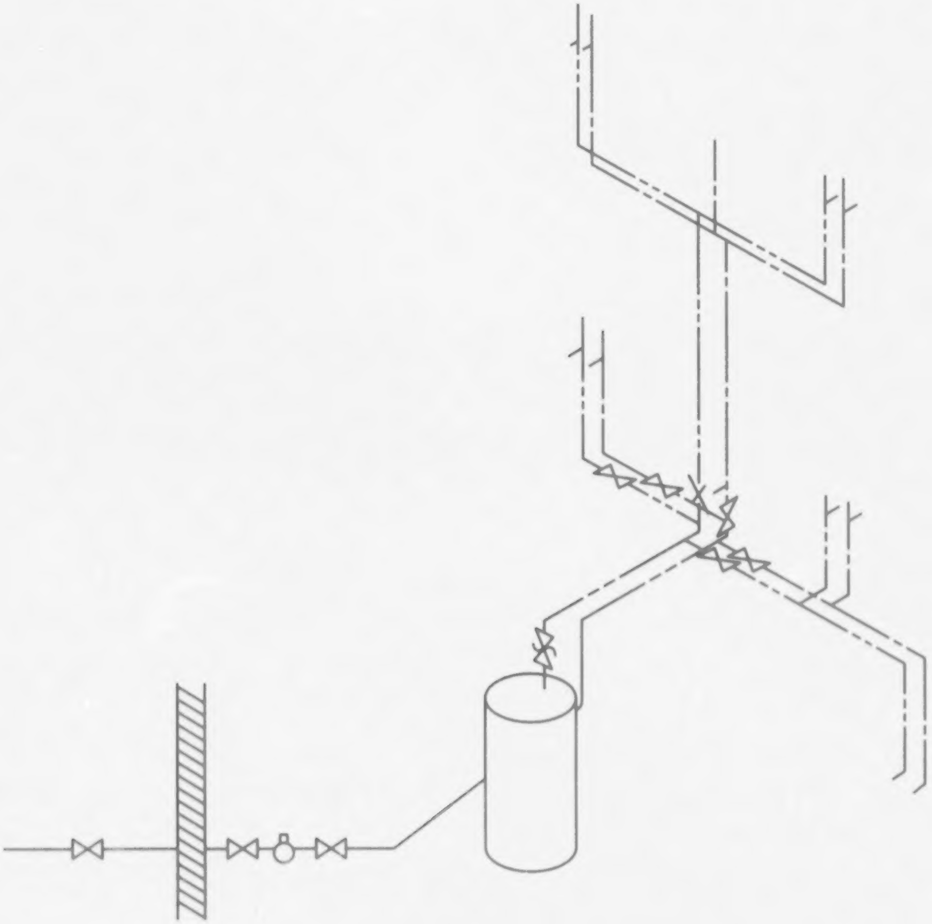
Suggested Supplemental Resources

- Massey, Howard C. *Plumber's Exam.* 5th ed. Carlsbad, CA: Craftsman Book Company, 1996.
- Massey, Howard C. *Plumber's Handbook.* 5th ed. Carlsbad, CA: Craftsman Book Company, 1994.

Water Systems
Unit 2-D

Answers to Assignment Sheets

Assignment Sheet 1—Make an Isometric Drawing of a Hot and Cold Water System for a Two-Story House



Assignment Sheet 2—Determine Pipe Sizes for a Hot and Cold Water System for a Two-Story House

A.	3/4″	E.	1/2″
B.	3/4″	F.	3/4″
C.	1/2″	G.	1/2″
D.	3/4″	H.	1/2″

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Water Systems
Unit 2-D

Written Test

Name ______________________ Date ____________ Score ____________

1. Match the terms on the right with their correct definitions.

_______ a. Any link between contaminated water and potable water in the water system

_______ b. Water which is satisfactory for drinking and domestic purposes

_______ c. The depth of frost penetration in the soil

_______ d. Amount of force or pressure created by the depth of one foot of water

_______ e. A faucet on the outside of the building to which a garden hose can be attached

_______ f. A full opening valve installed in the water line wherever a cut-off is required

_______ g. Flow pressure loss caused by liquid coming in contact with the inside of the pipe

1. Pressure head
2. Shut-off valve
3. Potable water
4. Sill cock
5. Frost line
6. Cross connection
7. Friction loss

2. Match the components of a water system in a single-family dwelling on the right with their functions. Write the corresponding numbers in the blanks provided. Functions continue on the next page.

_______ a. A large pipe, buried in the street, which distributes water throughout the town or city

_______ b. Water pipe which supplies water from the water main or other source of supply to the building served

_______ c. Records amount of water consumed by residence or dwelling

_______ d. A valve placed in the service line at or near the curb which permits easy control over the system

_______ e. A cylindrical casting placed over the curb stop to allow remote opening and closing of the stop

_______ f. Pipes which carry water from the service pipe to fixtures in the building

_______ g. A valve installed between the street and the water meter

1. Shut-off valve
2. Distribution pipes
3. Water meter
4. Water main
5. Curb stop
6. Meter stop
7. Air chamber
8. Corporation stop
9. Riser pipes
10. Curb box
11. Service pipe

_______ h. Pipes which rise vertically from a horizontal pipe

_______ i. A valve installed in the water line wherever a cut-off is required

_______ j. A closed section of pipe or coil, or a patented device designed to absorb shock caused by a rapidly closing valve or faucet; this prevents water-hammer and is installed at time of roughing in

_______ k. A valve installed in the service pipe at the water main

3. Select factors to consider when installing a hot water system by placing an "X" in the appropriate blanks.

_______ a. Inlet pipe to the water heater must be smaller than the outlet pipe.

_______ b. Hot water distribution pipes are equal in sizing and design to the cold water distribution pipe.

_______ c. Water heater is located according to source of cold water supply.

_______ d. Water heater is located according to source of fuel supply.

_______ e. Main hot water pipe should be larger in size than the main cold water pipe.

4. Select true statements about sizing of pipes in residential water systems by placing an "X" to the left of the true statements.

_______ a. Water pressure increases as the height of the water decreases.

_______ b. All distribution pipes are the same size, regardless of their fixture application.

_______ c. Number and type of fittings affect water pressure.

_______ d. Water pressure is increased by friction loss caused by the water coming in contact with the inside of the pipe.

_______ e. Most town or city water supplies are disbursed from elevated tanks which distribute the water by gravity.

_______ f. A 1 inch column of water will create .433 pounds per square inch of pressure at the base of the column.

Written Test

5. Distinguish between materials used for pipes and materials used for valves in water pipe systems. Place a "P" to the left of the materials used for pipes and a "V" to the left of those used for valves.

Note: Some materials may be used for both pipes and valves.

________ a. Brass

________ b. Plastic

________ c. Copper

________ d. Galvanized iron

6. Select true statements about the prevention of frozen pipes in cold weather by placing an "X" to the left of the true statements.

________ a. Avoid installing pipes in outside walls.

________ b. Outside building pipe lines must be buried above the frost line.

________ c. Avoid installing pipes in inside walls.

________ d. Insulate pipes in crawl spaces.

________ e. Install freeze-proof type hose bibs.

________ f. If pipe is installed in an area subject to freezing, avoid installing a drain valve.

________ g. If in doubt, insulate or relocate pipes.

________ h. Outside building pipe lines must be buried below frost line.

7. List four methods of preventing contamination of water systems by cross connections.

a. ____

b. ____

c. ____

d. ____

8. Complete the following statements concerning the two methods of testing a water system for leaks by circling the correct words.

   a. For the water method, the test pressure **(should, should not)** be less than the pressure of the system to be used.

   b. For the air method, the test pressure is usually 50 psi for **(15 minutes, 1 hour, 4 hours)**.

Permission to duplicate this test is granted.

Water Systems
Unit 2-D

Answers to Written Test

1. a. 6
   b. 3
   c. 5
   d. 1
   e. 4
   f. 2
   g. 7

2. a. 4
   b. 11
   c. 3
   d. 5
   e. 10
   f. 2
   g. 6
   h. 9
   i. 1
   j. 7
   k. 8

3. b, c, d

4. c, e

5. a. V
   b. P, V
   c. P
   d. P, V

6. a, d, e, g, h

7. a. Install properly designed fixtures and fittings that allow for sufficient air gap between water supply inlet and fixture rim.
   b. Install vacuum breakers where air gap is limited, to prevent contaminated water from backing up into sanitary water supply.
   c. Install a reduced pressure backflow preventer (B.F.P.) at each cross connection to provide protection of the potable water supply.
   d. Install a siphon breaker at water inlet supply to prevent siphonage of contaminated water into supply line.

8. a. Should not
   b. 4 hours

Water Systems
Unit 2-D

Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Assignment Sheet Ratings

Assignment Sheet 1—Make an Isometric Drawing of a Hot and Cold Water System for a Two-Story House Rating ________

Comments: ______________________________________

____

Assignment Sheet 2—Determine Pipe Sizes for a Hot and Cold Water System for a Two-Story House Rating ________

Comments: ______________________________________

____

Job Sheet Ratings

Job Sheet 1—Rough-in Water Supply Lines for Bathtubs Rating ________

Comments: ______________________________________

____

Job Sheet 2—Rough-in Water Supply Lines for a Water Closet Rating ________

Comments: ______________________________________

____

Job Sheet 3—Rough-in Water Supply Lines for a Water Heater Rating ________

Comments: ______________________________________

____

Job Sheet 4—Make Water Pressure Tests on Water Supply Systems Rating ________

Comments: ______________________________________

____

Unit Evaluation Form

Written Test Scores

Pretest ____________ Posttest ____________ Other ____________

Other ____

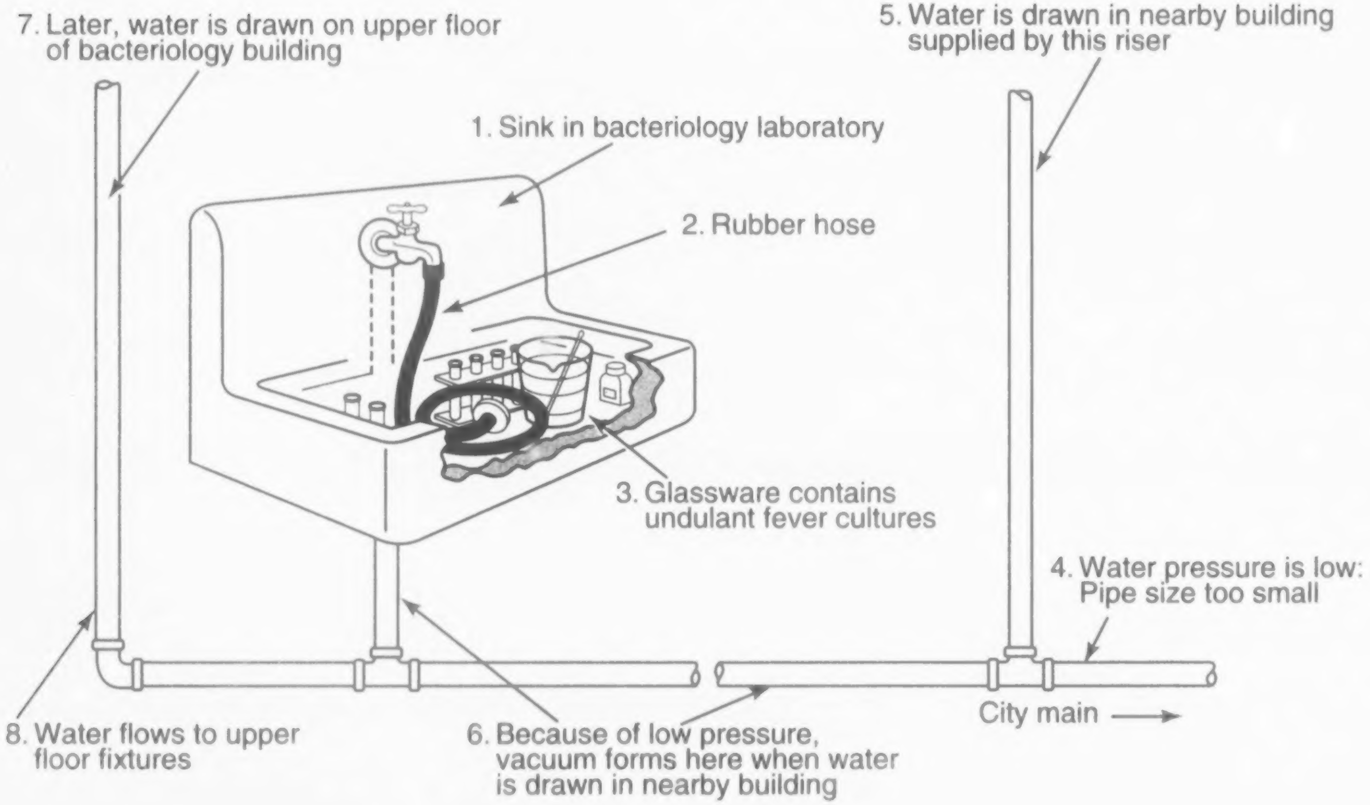
____

Teacher Signature ______________________________ Date ________________

Student Signature ______________________________ Date ________________

Permission to duplicate this form is granted.

How Water is Contaminated


7. Later, water is drawn on upper floor of bacteriology building
5. Water is drawn in nearby building supplied by this riser
1. Sink in bacteriology laboratory
2. Rubber hose
3. Glassware contains undulant fever cultures
4. Water pressure is low: Pipe size too small
City main
8. Water flows to upper floor fixtures
6. Because of low pressure, vacuum forms here when water is drawn in nearby building

TM 1

Joining Pipes
Unit 3-D

Unit Contents

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Suggested Activities. 3
Written Test 7
Answers to Written Test 13
Unit Evaluation Form 15

Student Components **Page**

Objective Sheet D-77
Information Sheet D-79
Job Sheets
- 1—Cut, Ream, Thread, and Join a Piece of 1″ Galvanized Steel Pipe to a 1″ Fitting D-85
- 2—Join Cast Iron Pipe to a Cast Iron Fitting Using a No-Hub Joint D-91
- 3—Join Cast Iron Pipe to a Cast Iron Fitting Using a Compression Joint D-93
- 4—Cut, Ream, and Join Copper Tubing Using the Sweat Method D-95
- 5—Cut, Ream, and Join Copper Tubing Using a Compression Joint D-99
- 6—Cut, Ream, and Join Copper Tubing Using a Flare Joint D-101
- 7—Cut, Ream, and Join Copper Tubing Using a Hammered Flare Joint D-105
- 8—Cut, Ream, and Join PVC Pipe to a PVC Fitting D-107
- 9—Cut, Ream, and Join Flexible Plastic Pipe With Insert Fittings D-111
- 10—Join Clay Pipe With Couplings D-113
- 11—Wipe Clay Pipe Joints D-115
- 12—Cut Cast Iron Soil Pipe With Snap-Type Chain Cutter D-117
- 13—Bend Copper Tubing With a Spring Bender D-119
- 14—Thread Steel Pipe With an Adjustable Die D-121
- 15—Join Cast Iron Pipe to Clay Pipe D-123
- 16—Join Ductile Iron Pipe Using the Roll-Grooved Coupling Method D-125

Joining Pipes
Unit 3-D

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resources Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Review "Instructions for Evaluating Student Performance."
- Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

Unit Introduction

- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss and demonstrate the job sheets. Make sure all required tools, joining pipes, and materials are available. Review criteria for evaluation of these activities.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Discuss and demonstrate the caulking method of joining cast iron pipe if it is commonly used in your area. **(Listening; and technology application)**
- Review the proper use and care of the acetylene torch. **(Listening; material and facilities; technology application; and maintenance and troubleshooting)**
- Show examples of the actual tools, materials, and equipment used for joining various types of pipe. **(Listening; material and facilities; and materials selection)**
- Have the students research why care must be taken when joining two different kinds of plastic pipe. **(Reading; decision making; problem solving; knowing how to learn; reasoning; information acquisition and evaluation and interpretation; and selection)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.
- Make copies of the written test. Add or modify test items as needed.
- Give and evaluate written test.
- Compile the job sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignments or supplemental activities that should be part of the unit evaluation.
- Meet individually with students to evaluate their progress through this unit of instruction and indicate to them possible areas of improvement.
- Reteach and retest as required.

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Suggested Activities

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

Resources Used in Developing This Unit

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- Blankenbaker, Keith E. *Modern Plumbing*. South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.

Suggested Supplemental Resources

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- Massey, Howard C. *Plumber's Handbook*. 5th ed. Carlsbad, CA: Craftsman Book Company, 1994.

Joining Pipes
Unit 3-D

Written Test

Name ____________________ Date __________ Score __________

1. Match the terms on the right with the correct definitions.

_____ a. Method of using a solvent to join PVC pipe

_____ b. Method of joining copper tubing using flux and solder applied with heat

_____ c. Removing burrs from inside edge of pipe

_____ d. Type of cast iron pipe to be joined by special fittings

_____ e. Cutting spiral grooves on the end of pipe to facilitate joining with a fitting or another pipe

_____ f. Substance applied to pipe threads to help seal the joint

_____ g. Expanded end of cast iron pipe which receives the spigot end of pipe or fitting

_____ h. Method of joining flexible plastic pipe

_____ i. End of fitting or pipe which is inserted into hub (or bell)

_____ j. Insert in cast iron hub which makes up part of a watertight compression joint

1. Threading
2. Cementing
3. Insert joining
4. Reaming
5. No-hub
6. Neoprene gasket
7. Hub
8. Spigot end
9. Pipe compound (dope)
10. Sweating

2. Select tools, materials, and equipment necessary to join steel pipe by placing an "X" in the appropriate blanks.

_____ a. Cutter

_____ b. Reamer

_____ c. Open end wrench

_____ d. Oil can

_____ e. Aviation wire snips

_____ f. Pipe vise

_____ g. Adjustable stock-and-die set

_______ h. Screwdriver

_______ i. Pipe compound (dope)

_______ j. Paint

_______ k. Pipe wrench

_______ l. Pipe

_______ m. Fitting

3. Select tools, materials, and equipment necessary to join cast iron pipe by the compression and no-hub methods by placing an "X" in the appropriate blanks.

   a. Compression method

      _______ 1) Neoprene gasket

      _______ 2) Fitting

      _______ 3) Gasket lubricant

      _______ 4) Lead hammer

      _______ 5) Lead

      _______ 6) Pipe puller

   b. No-hub method

      _______ 1) Neoprene gasket

      _______ 2) Stainless steel shield and clamp assembly

      _______ 3) Lead hammer

      _______ 4) Torque wrench

      _______ 5) Pipe

      _______ 6) Fitting

4. Select tools, materials, and equipment necessary to join copper tubing by the sweat joint, compression, and flare methods by placing an "X" in the appropriate blanks.

   a. Sweat joint method

      _______ 1) Tubing cutter

      _______ 2) Fitting

      _______ 3) Type B gas tank with wrench

_________ 4) Open-end wrench

_________ 5) Flux with brush

_________ 6) Sand cloth, emery cloth, steel wool

_________ 7) Solvent cement

_________ 8) Wire solder

_________ 9) Tubing

_________ 10) Handsaw

_________ 11) Torch

_________ 12) Striker

b. Compression method

_________ 1) Tubing cutter

_________ 2) Wire solder

_________ 3) Reamer

_________ 4) Flare-nut wrench

_________ 5) Tubing

_________ 6) Fitting

c. Flare method

_________ 1) Tubing cutter

_________ 2) Torch

_________ 3) Flaring tool and block

_________ 4) Cleaning solvent

_________ 5) Reamer

_________ 6) Flare-nut wrench

_________ 7) Open-end wrench

Written Test

5. Select tools, materials, and equipment necessary to join PVC and flexible plastic pipe by placing an "X" in the appropriate blanks.

   a. PVC pipe

   _________ 1) Handsaw

   _________ 2) Reamer

   _________ 3) Clamp

   _________ 4) Screwdriver

   _________ 5) Solvent cement with brush

   _________ 6) Pipe

   _________ 7) Cleaning solvent with brush

   b. Flexible plastic pipe

   _________ 1) Reamer

   _________ 2) Pipe

   _________ 3) Clamp

   _________ 4) Socket wrench

   _________ 5) Solvent cement

   _________ 6) Flaring tool and block

   _________ 7) Pipe cutter

6. Select tools, materials, and equipment necessary to join pipe by using the roll-grooved coupling method by placing an "X" in the appropriate blanks.

   ________ a. Cutter

   ________ b. Roll pipe groover

   ________ c. Screwdriver

   ________ d. Grooved coupling (or housing)

   ________ e. Grooved coupling gasket

   ________ f. Flare-nut wrench

   ________ g. Non-petroleum based lubricant

   ________ h. Socket wrench

Written Test

_______ i. Clean cloth

_______ j. Pipe

_______ k. Handsaw

Permission to duplicate this test is granted.

Joining Pipes
Unit 3-D

Answers to Written Test

1. a. 2
   b. 10
   c. 4
   d. 5
   e. 1
   f. 9
   g. 7
   h. 3
   i. 8
   j. 6

2. a, b, d, f, g, i, k, l, m

3. a. 1, 2, 3, 4, 6
   b. 1, 2, 4, 5, 6

4. a. 1, 2, 3, 5, 6, 8, 9, 11, 12
   b. 1, 3, 4, 5, 6
   c. 1, 3, 5, 6, 7

5. a. 1, 2, 5, 6, 7
   b. 1, 2, 3, 4, 7

6. b, d, e, g, h, i, j

Joining Pipes
Unit 3-D

Unit Evaluation Form

Student Name ______________________________ Unit Rating ____________

Job Sheet Ratings

Job Sheet 1—Cut, Ream, Thread and Join a Piece of 1″ Galvanized Steel Pipe to a 1″ Fitting Rating ________

Comments: ____

____

Job Sheet 2—Join Cast Iron Pipe to a Cast Iron Fitting Using a No-Hub Joint Rating ________

Comments: ____

____

Job Sheet 3—Join Cast Iron Pipe to a Cast Iron Fitting Using a Compression Joint Rating ________

Comments: ____

____

Job Sheet 4—Cut, Ream, and Join Copper Tubing Using the Sweat Method Rating ________

Comments: ____

____

Job Sheet 5—Cut, Ream, and Join Copper Tubing Using a Compression Joint Rating ________

Comments: ____

____

Job Sheet 6—Cut, Ream, and Join Copper Tubing Using a Flare Joint Rating ________

Comments: ____

____

Unit Evaluation Form

Job Sheet 7—Cut, Ream, and Join Copper Tubing Using a Hammered Flare Joint Rating ________

Comments: ____

____

Job Sheet 8—Cut, Ream, and Join PVC Pipe to a PVC Fitting Rating ________

Comments: ____

____

Job Sheet 9—Cut, Ream, and Join Flexible Pipe With Insert Fittings Rating ________

Comments: ____

____

Job Sheet 10—Join Clay Pipe With Couplings Rating ________

Comments: ____

____

Job Sheet 11—Wipe Clay Pipe Joints Rating ________

Comments: ____

____

Job Sheet 12—Cut Cast Iron Soil Pipe With Snap-Type Chain Cutter Rating ________

Comments: ____

____

Job Sheet 13—Bend Copper Tubing With a Spring Bender Rating ________

Comments: ____

____

Job Sheet 14—Thread Steel Pipe With an Adjustable Die Rating ________

Comments: ____

____

Unit Evaluation Form

Job Sheet 15—Join Cast Iron Pipe to Clay Pipe Rating ________

Comments: ____

____

Job Sheet 16—Join Ductile Iron Pipe Using the Roll-Grooved Coupling Method Rating ________

Comments: ____

____

Written Test Scores

Pretest ________ Posttest ________ Other ________

Other ____

____

Teacher Signature ______________________ Date ____________

Student Signature ______________________ Date ____________

Permission to duplicate this form is granted.

Pipe Fittings
Unit 4-D

Unit Contents

Teacher Components **Page**

Suggested Activities 3
Answers to Assignment Sheets 7
Written Test 9
Answers to Written Test 15
Unit Evaluation Form 17

Student Components **Page**

Objective Sheet D-129
Information Sheet D-131
Assignment Sheets
  1—Read Fitting Sizes D-143
  2—Identify Fittings From a Sketch of a Piping System D-145

206

Pipe Fittings
Unit 4-D

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resources Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

Unit Introduction

- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss the assignment sheets. Review with students the criteria for evaluation of these activities.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000.* These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Show examples of the different types of pipe fittings, and use actual pipe fittings to evaluate students' ability to identify various types of pipe fittings. **(Listening; seeing things in the mind's eye; and material selection)**
- Discuss the uses of the different types of pipe fittings. **(Listening; reasoning; and material selection)**
- Conduct a tour of the school's plumbing supply storage. **(Listening; and material and facilities)**
- Discuss and show examples of new materials that are being used for pipe fittings and compare the advantages and disadvantages of each. **(Listening; reasoning; and material selection)**
- Have students research and compare cost of different types of pipe fittings. **(Reading; mathematics; reasoning; money; material and facilities; and information acquisition and evaluation)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.
- Make copies of the written test. Add or modify test items as needed.
- Give and evaluate written test.
- Compile the assignment sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignments or supplemental activities that should be part of the unit evaluation.
- Meet individually with students to evaluate their progress through this unit of instruction and indicate to them possible areas of improvement.
- Reteach and retest as required.

Resources Used in Developing This Unit

- Barclay, Leney. *Residential Plumbing.* Revised by Hank Johnson. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1985.
- Blankenbaker, Keith E. *Modern Plumbing.* South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.

Suggested Supplemental Resources

- Massey, Howard C. *Plumber's Exam*. 5th ed. Carlsbad, CA: Craftsman Book Company, 1996.
- Massey, Howard C. *Plumber's Handbook*. 5th ed. Carlsbad, CA: Craftsman Book Company, 1994.

Pipe Fittings
Unit 4-D

Answers to Assignment Sheets

Assignment Sheet 1—Read Fitting Sizes

1. 3/4″ x 1/2″ x 1/2″ galvanized iron tee
2. 3/4″ x 1/2″ x 1/2″ copper tee
3. 1″ x 1/2″ galvanized iron tee
4. 3/4″ x 1/2″ x 3/4″ copper tee

Assignment Sheet 2—Identify Fittings From a Sketch of a Piping System

a. Street elbow
b. Short nipple
c. Coupling
d. Cross
e. Plug
f. Bushing
g. Union
h. Cap
i. Elbow
j. Close nipple
k. Tee
l. Reducing coupling

Pipe Fittings
Unit 4-D

Written Test

Name ________________________________ Date ______________ Score _____________

1. Match terms on the right with their definitions.

_______ a. Those parts of the piping system which are used to join pipes and tubes

_______ b. Type of fitting which joins pipes of different materials

_______ c. Fitting used to reduce size

_______ d. The connection of pipe to fitting or any combination of fittings and pipes

_______ e. A substance used on threaded joints to help make them tight, to lubricate them, and to fill in imperfections

_______ f. Fitting designed especially for drainage, allowing the connecting pipe a 2° pitch

_______ g. Fitting designed to withstand specified pressure

_______ h. That space which the pipe requires in the fitting

_______ i. Fittings which have been annealed to reduce brittleness

_______ j. Loosely woven hemp rope which has been treated with a waterproofing substance and is used to make caulked joints in cast iron pipe systems

_______ k. Female pipe thread

_______ l. Male pipe thread

_______ m. Not brittle; capable of being shaped

_______ n. Inflexible

_______ o. Substitute for pipe compound

1. Malleable iron fittings
2. Pressure fitting
3. FPT
4. Pipe joint compound
5. Adapter
6. Fitting gain
7. MPT
8. Oakum
9. Drainage fitting
10. Joint
11. Bushing
12. Fittings
13. Rigid
14. Thread tape
15. Malleable

Written Test

2. Match the materials used to make pipe fittings with their specific uses, types, and properties. Write the corresponding numbers in the blanks provided.

_______ a. Uses—drains, sewers, and vents; types—hub and spigot, and no-hub; properties—very brittle, cannot withstand rough treatment, rigid, heavy, needs strong support or base

_______ b. Uses—water services and distribution, drainage (above ground), vents, and gas (LPG); types—wrought and cast (brass); properties—fairly malleable, rigid, and lightweight, needs light support

_______ c. Uses—drains, vents, water services, and irrigation; common types PVC (polyvinyl chloride), PE (polyethylene), and PB (polybutylene); properties—very malleable, PVC is fairly rigid, PE is fairly flexible, and lightweight, needs support

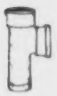
_______ d. Uses—gas pipe (black), water service and distribution (galvanized); types—black iron and galvanized; properties—fairly malleable, rigid, heavy, needs strong support or base, and tends to rust

_______ e. Uses—gas lines, water services and distribution; types—compression and flare; properties—fairly malleable, rigid, and lightweight, needs little support

_______ f. Uses—house sewer and city sewer; type—hub (bell) and spigot, and plain end with coupling; properties—very brittle, rigid, and medium weight

1. Plastic
2. Malleable cast iron
3. Cast iron
4. Vitrified clay
5. Copper
6. Brass

3. Identify basic plumbing branches. Write your answers in the blanks provided.



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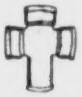

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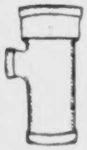

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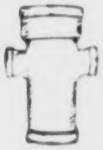

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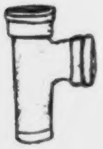
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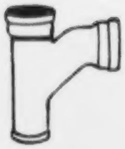
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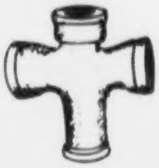
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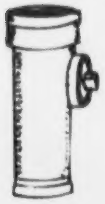
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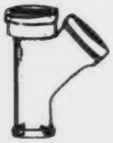
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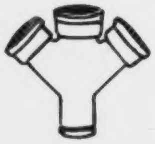
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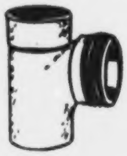
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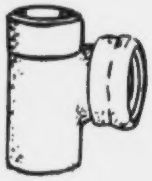
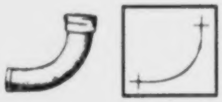

l. ________________

4. Identify basic plumbing bends. Write your answers in the blanks provided.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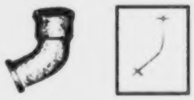
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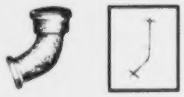
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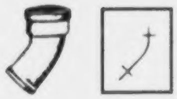
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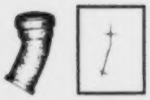
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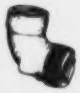
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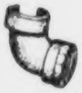
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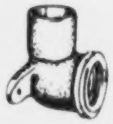
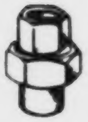

h. ________________

5. Identify basic unions and couplings. Write your answers in the blanks provided.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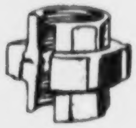
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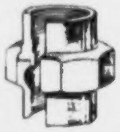
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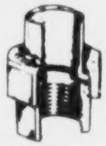
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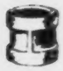
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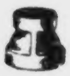
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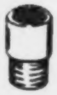
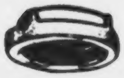

g. ________________

Written Test

6. Identify basic caps and plugs. Write your answers in the blanks provided.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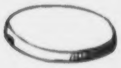
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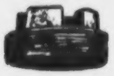
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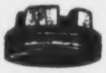
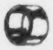

d. ______________

7. Identify basic bushings and nipples. Write your answers in the blanks provided.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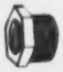
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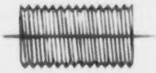
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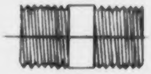
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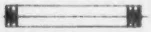
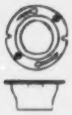

e. ______________

8. Identify basic closet flanges and cleanouts. Write your answers in the blanks provided.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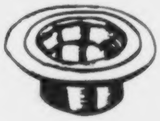
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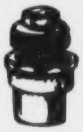
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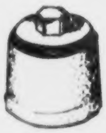
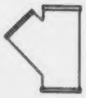

d. ______________

9. Identify basic no-hub fittings. Write your answers in the blanks provided.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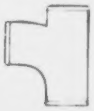
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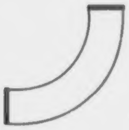
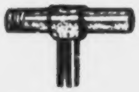

c. ______________

10. Identify flexible plastic (PE) insert fittings. Write your answers in the blanks provided.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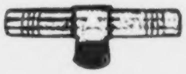
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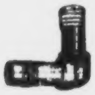
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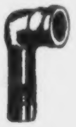
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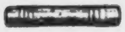
Written Test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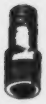
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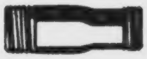
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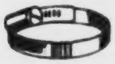
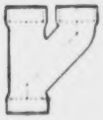

h. ______________

11. Identify PVC-DWV fittings. Write your answers in the blanks provided.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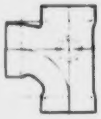
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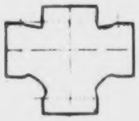
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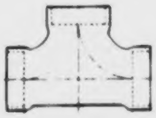
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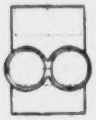
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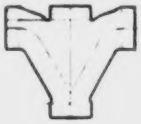
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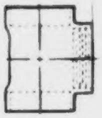
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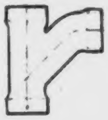
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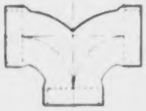
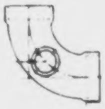

i. ______________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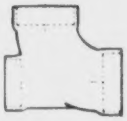
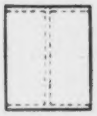

k. ______________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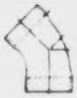
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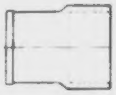
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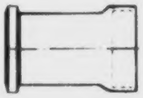
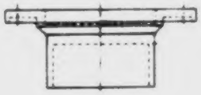

o. ______________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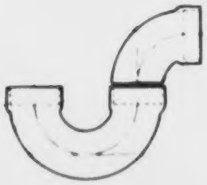
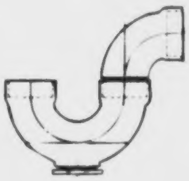
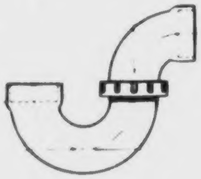
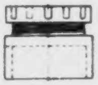

q. ______________

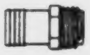

r. ______________


s. ______________

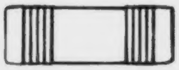

t. ______________

Written Test

12. Identify polybutylene fittings. Write your answers in the blanks provided.



a. ______________



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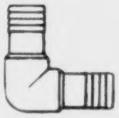
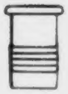


c. ______________



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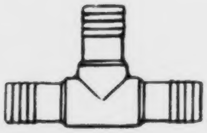
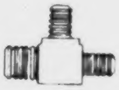


e. ______________



f. ______________

13. Distinguish between the two types of malleable iron fittings (drainage and pressure) by placing an "X" next to the description of drainage fittings.

________ a. Those parts of the piping system which are used to join pipes and tubes

________ b. Used for gas and air vent lines

________ c. Used for drainage lines

________ d. Fittings are tapped with a pitch of 1/4" per foot

________ e. The insides of these fittings are smooth and shaped for easy flow.

14. Select four types of adapters by placing an "X" in the appropriate blanks.

________ a. Copper to cast iron (caulked)

________ b. Copper to threaded pipe

________ c. Copper to PVC

________ d. PVC to vitrified clay

________ e. PVC to cast iron

________ f. PVC to threaded pipe

Permission to duplicate this test is granted.

Pipe Fittings
Unit 4-D

Answers to Written Test

1. a. 12
b. 5
c. 11
d. 10
e. 4
f. 9
g. 2
h. 6
i. 1
j. 8
k. 3
l. 7
m. 15
n. 13
o. 14

2. a. 3
b. 5
c. 1
d. 2
e. 6
f. 4

3. a. Tee
b. Double tee
c. Tapped tee
d. Double tapped tee
e. Sanitary tee
f. Long turn sanitary tee (combination wye and 1/8 bend)
g. Double sanitary tee
h. Test tee
i. Wye
j. Double wye
k. Male adapter
l. Female adapter

4. a. Quarter (1/4) bend (90°)
b. Fifth (1/5) bend (72°)
c. Sixth (1/6) bend (60°)
d. Eighth (1/8) bend (45°)
e. Sixteenth (1/16) bend (22.5°)
f. Male street elbow
g. Adapter elbow
h. Drop-ear elbow

5. a Straight union
b. Ground joint union
c. Gasket type union
d. Dielectric union
e. Straight coupling
f. Reducing coupling
g. Male to female adapter coupling

6. a. Cast iron cap
b. Test cap (copper)
c. Solid plug
d. Cored plug

Answers to Written Test

7. a. Copper bushing
   b. Malleable cast iron bushing
   c. Close nipple
   d. Shoulder nipple
   e. Long nipple

8. a. No-hub slot and notch flange
   b. PVC flange
   c. Copper cleanout
   d. Cast iron cleanout

9. a. Wye
   b. Sanitary tee
   c. Long turn 1/4 bend

10. a. Tee
    b. Tapped tee
    c. 90° elbow
    d. 90° female adapter elbow
    e. Coupling
    f. Male adapter elbow
    g. Male steel adapter
    h. Clamp

11. a. Upright wye
    b. Sanitary tee with left side inlet
    c. Double sanitary tee
    d. Two-way cleanout
    e. Horizontal twin tee (frog eye tee)
    f. Double combination wye and 1/8 bend
    g. Cleanout tee (test tee)
    h. Combination wye and 1/8 bend
    i. Double 1/4 bend
    j. Long sweep 1/4 bend with side inlet
    k. 1/4 bend with low heel inlet (all hub)
    l. Coupling
    m. 1/8 bend
    n. No-hub adapter
    o. Hub adapter
    p. Closet flange
    q. P-trap
    r. P-trap with cleanout
    s. P-trap with union
    t. Trap adapter

12. a. Insert male adapter
    b. Insert coupling
    c. Insert elbow
    d. Insert plug
    e. Insert tee
    f. Reducer tee

13. c, d, e

14. a, b, e, f

Pipe Fittings
Unit 4-D

Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Assignment Sheet Ratings

Assignment Sheet 1—Read Fitting Sizes Rating ______

Comments: ______________________

Assignment Sheet 2—Identify Fittings From a Sketch of a Piping System Rating ______

Comments: ______________________

Written Test Scores

Pretest ______ Posttest ______ Other ______

Other ______________________

Teacher Signature ______________________ Date __________

Student Signature ______________________ Date __________

Permission to duplicate this form is granted.

Pipe
Unit 5-D

Unit Contents

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Written Test 9
Answers to Written Test 13
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Information Sheet D-149
Assignment Sheet 1—Construct a Materials Take-Off List
From an Isometric Drawing D-155

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Pipe
Unit 5-D

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resources Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

Unit Introduction

- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss the assignment sheet. Review with students the criteria for evaluation of these activities.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000.* These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Conduct a tour of a pipe supply storage room. **(Listening; and material and facilities)**
- Conduct a tour of the school's piping systems. **(Listening; material and facilities; and interrelationships)**

  Note: Use the local plumbing code book as a guide.
- Show examples of different types of pipe used in plumbing. **(Listening; and material selection)**
- Have the students practice the three methods of measuring pipe on actual pipes and pipe fitting combinations as discussed in objective 7 of the information sheet. **(Mathematics; and technology application)**
- Show the students examples of different types of copper pipe, and have the students identify them according to their identification colors. (**Listening; material and facilities; and material selection)**
- Have the students research how plastic, copper, cast iron, or galvanized pipe is manufactured. **(Reading; writing; knowing how to learn; acquisition and evaluation; organization and storage; and information interpretation)**
- Have the students compare the relative cost of different fittings and pipe materials. **(Reading; mathematics; decision making; problem solving; reasoning; money; and material and facilities selection)**
- Invite a journeyman plumber or master plumber to visit the class and discuss advantages and disadvantages of different piping system materials. (**Listening; mathematics; decision making; money; material and facilities; and material selection)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.
- Make copies of the written test. Add or modify test items as needed.
- Give and evaluate written test.
- Compile the assignment sheet rating and written test scores on the Unit Evaluation Form. Include any additional assignments or supplemental activities that should be part of the unit evaluation.
- Meet individually with students to evaluate their progress through this unit of instruction and indicate to them possible areas of improvement.
- Reteach and retest as required.

Suggested Activities

Resources Used in Developing This Unit

- Barclay, Leney. *Residential Plumbing*. Revised by Hank Johnson. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1985.

- Blankenbaker, Keith E. *Modern Plumbing*. South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.

Suggested Supplemental Resources

- Massey, Howard C. *Plumber's Exam*. 5th ed. Carlsbad, CA: Craftsman Book Company, 1996.

- Massey, Howard C. *Plumber's Handbook*. 5th ed. Carlsbad, CA: Craftsman Book Company, 1994.

Answers to Assignment Sheet 1—Construct a Materials Take-Off List From an Isometric Drawing

	Materials	Total Number
1.	3″ x 5′ cast iron double-hub pipe	1
2.	3″ x 5′ cast iron single-hub pipe	2
3.	3″ CI Y	2
4.	3″ CI long turn ell	2
5.	3″ clean-out	1
6.	3″ CI P-trap	1
7.	3″ CI floor drain	1
8.	3″ x 1 1/2″ CI TY	1
9.	3″ x 1 1/2″ CI reducing bushing	1
10.	21′ x 1 1/2″ galvanized steel pipe	1
11.	1 1/2″ galvanized steel 90° ell	1
12.	1 1/2″ galvanized steel nipple	2
13.	1 1/2″ galvanized steel P-trap	1
14.	1 1/2″ galvanized steel 45° ell	2
15.	1 1/2″ x 2″ coupling	1
16.	3′ x 2″ galvanized pipe	1
17.	2″ roof flashing	1

Pipe
Unit 5-D

Written Test

Name ______________________ Date __________ Score __________

1. Match the terms on the right with their definitions.

________ a. Rigid plastic pipe

________ b. Name size of pipe rather than actual size

________ c. Plastic pipe which comes in a roll and uses slip-in fittings with clamps

________ d. Laws and regulations which stipulate type, size, and quality of pipe material to use

________ e. Short piece of pipe, 12" or less in length

________ f. Fluid-carrying pipe which has a thin wall

________ g. To coat metal by hot dipping with zinc in order to prevent rusting

1. Tube
2. Galvanize
3. Plumbing code
4. Nominal size
5. PVC
6. Nipple
7. Flexible plastic pipe

2. Select six types of pipes used in residential plumbing by placing an "X" in the appropriate blanks.

________ a. Black steel

________ b. Galvanized steel

________ c. Cast iron

________ d. Brick

________ e. PDT plastic

________ f. PE (polyethylene)

________ g. Ivory

________ h. Copper

________ i. Wood

________ j. Vitrified clay

Written Test

3. Match the identification colors on the right with the correct types of copper pipe. Write the corresponding number in the blanks provided. Identification colors may be used more than once.

________ a. L-soft

________ b. K-soft

________ c. DWV-Rigid

________ d. K-Rigid

________ e. M-Rigid

________ f. L-Rigid

1. Yellow

2 Red

3. Blue

4. Green

4. List one application for each type of pipe to be used in the plumbing trade. Write your answers in the blanks provided.

   a. Black steel—________________________________

   b. Galvanized steel—________________________________

   c. Plastic—________________________________

   d. Copper—________________________________

   e. Cast iron—________________________________

   f. Vitrified clay—________________________________

5. Distinguish between black steel and galvanized steel pipe by placing an "X" next to the descriptions of galvanized steel pipe.

________ a. Is used for applications with corrosive liquids such as water

________ b. Is limited to use with noncorrosive substances such as gas, air, and steam

________ c. Is varnished black to help prevent rust

________ d. Is hot dipped in zinc to resist rusting

6. List three advantages and two disadvantages of plastic pipe. Write your answers in the blanks provided.

   a. Advantages

      1) ________________________________

      2) ________________________________

      3) ________________________________

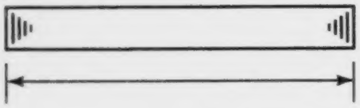
Written Test

b. Disadvantages

1) ______________________________

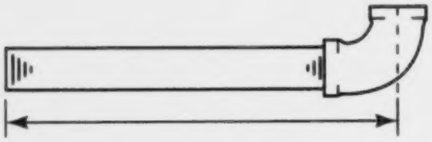
2) ______________________________

7. Discuss the three common methods of measuring pipe using the illustrations below. Write your answers in the blanks provided.



a. ______________________________

____



b. ______________________________

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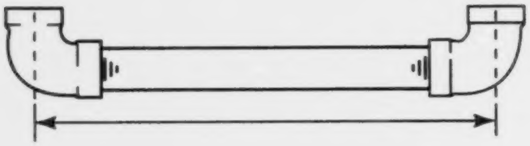

c. ______________________________

____

Permission to duplicate this test is granted.

Pipe
Unit 5-D

Answers to Written Test

1.
    - a. 5
    - b. 4
    - c. 7
    - d. 3
    - e. 6
    - f. 1
    - g. 2

2. a, b, c, f, h, j

3.
    - a. 3
    - b. 4
    - c. 1
    - d. 4
    - e. 2
    - f. 3

4. Any one under each type of pipe:
    - a. Black steel pipe
        - 1) Natural gas lines
        - 2) Liquefied petroleum gas lines
    - b. Galvanized steel pipe
        - 1) Drain lines
        - 2) Vent lines
        - 3) Water lines
    - c. Plastic pipe
        - 1) Water supply lines
        - 2) Underground gas lines
        - 3) Drain lines
        - 4) Vent lines
    - d. Copper
        - 1) Water lines
        - 2) Drain lines
        - 3) Vent lines
        - 4) Gas lines
    - e. Cast iron
        - 1) Drain lines
        - 2) Vent lines
    - f. Vitrified clay
        - 1) Sewer lines
        - 2) Storm drains

5. a, d

6.
    - a. Advantages—Any three of the following:
        - 1) Is lightweight
        - 2) Resists corrosion and electrolysis
        - 3) Is easily installed
        - 4) Is comparatively inexpensive
    - b. Disadvantages
        - 1) Will not withstand temperatures over 150°F
        - 2) Is not stable at pressures over 100 psi

7.
    - a. End to end—Measure pipe end to end without fittings
    - b. End to center—Measure from end of pipe to center of fitting
    - c. Center to center—Measure from center of one fitting to the center of the other

Pipe
Unit 5-D

Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Assignment Sheet Rating

Assignment Sheet 1—Construct a Materials Take-Off List From an Isometric Drawing Rating ______

Comments: ______________________________________

____

Written Test Scores

Pretest ______ Posttest ______ Other ______

Other ______________________________________

____

Teacher Signature ______________________ Date __________

Student Signature ______________________ Date __________

Permission to duplicate this form is granted.

Private Water Systems
Unit 1-E

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Private Water Systems
Unit 1-E

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resources Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Make transparencies from the transparency masters included in this unit.
- Review "Instructions for Evaluating Student Performance."
- Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

Unit Introduction

- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss the assignment sheet. Review with students the criteria for evaluation of this activity.
- Discuss and demonstrate the job sheet. Make sure all required tools, equipment, and supplies are available. Review criteria for evaluation of this activity.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Show the students examples of different types of pumps and discuss the advantages and disadvantages of each. **(Listening; decision making; reasoning; and material and selection)**
- Have the students study cross sections of different types of water pumps and identify the principal parts of each. **(Seeing things in the mind's eye)**
- Show the students examples of different types of pump controls used on private water systems. **(Listening)**
- Have a manufacturer's representative visit the class to discuss the manufacturer's specifications for the pump and controls the students will be installing in Job Sheet 1. **(Listening; reasoning; and information acquisition and evaluation)**
- Visit a well-drilling site with the class. Ask the driller to discuss the procedures for locating water, drilling the well, installing the well casing, and capping the well. **(Listening; reasoning; and technology application)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.
- Make copies of the written test. Add or modify test items as needed.
- Give and evaluate written test.
- Compile the assignment sheet rating, the job sheet rating, and written test score on the Unit Evaluation Form. Include any additional assignments or supplemental activities that should be part of the unit evaluation.
- Meet individually with students to evaluate their progress through this unit of instruction and indicate to them possible areas of improvement.
- Reteach and retest as required.

Suggested Activities

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

Resources Used in Developing This Unit

- Barclay, Leney. *Residential Plumbing*. Revised by Hank Johnson. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1985.

- Blankenbaker, Keith E. *Modern Plumbing*. South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.

- Henderson, G. E. *Planning for an Individual Water System*. Winterville, GA: American Association for Vocational Materials, 1982.

Suggested Supplemental Resources

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- Massey, Howard C. *Plumber's Handbook*. 5th ed. Carlsbad, CA: Craftsman Book Company, 1994.

Private Water Systems
Unit 1-E

Written Test

Name ______________________ Date ____________ Score ____________

1. Match the terms on the right with the correct definitions.

______ a. Water that is free from impurities which cause disease or harmful effects

______ b. A device that uses mechanical power to move or lift liquid from one point to another

______ c. A safety device installed in a water system to automatically reduce excess pressure

______ d. A device placed at the lower end of the suction pipe in order to keep the pipe full of water

______ e. A valve that allows water to flow in only one direction

______ f. Pipe that carries water from its source, such as a well or spring box, to the pump

______ g. Pipe that carries water from the pump to the pressure tank or water system

______ h. A device that receives the discharge from the pump and develops pressure by compressing air

______ i. A water controller that is used to isolate parts of the pumping system

______ j. The height to which underground water will be found in a specific location

______ k. Pounds per square inch; the measurement of pressure in water systems

______ l. Subsoil section, usually containing clay or rock, which resists or prevents flow or absorption of water

______ m. Operating in a circular motion

______ n. Operating in a back-and-forth motion

1. Relief valve
2. Suction line
3. Gate valve
4. PSI
5. Reciprocating
6. Pressure tank
7. Potable water
8. Foot valve
9. Pump
10. Check valve
11. Discharge line
12. Impervious layer
13. Centrifugal
14. Water table

Written Test

2. Select true statements concerning types of private water supplies by placing an "X" next to the true statements.

_____ a. A dug well consists of a hole in the ground from 3′ to 20′ in diameter and deep enough to extend below the ground water table.

_____ b. A driven well is made with an earth auger, either hand or power operated.

_____ c. A spring is water that rises to the surface from an underground source.

_____ d. A bored well consists of a pipe with a device on the lower end which is screened to allow ground water to enter the pipe.

_____ e. A drilled well consists of a steel pipe, from 4″ to 6″ in diameter, used as a casing to protect the hole from cave-ins and other disturbances.

_____ f. Storage tanks provide water collected from rain or subsurface ground.

3. List six possible sources of contamination in private water supplies.

a. ____________________

b. ____________________

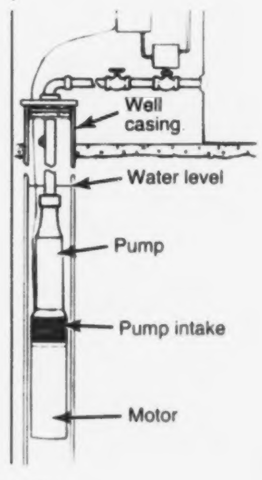
c. ____________________

d. ____________________

e. ____________________

f. ____________________

4. Identify types of pumps used for private water systems.



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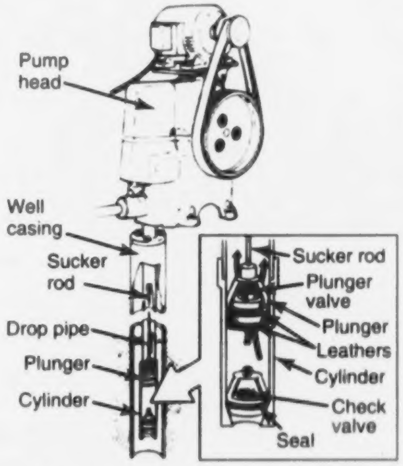

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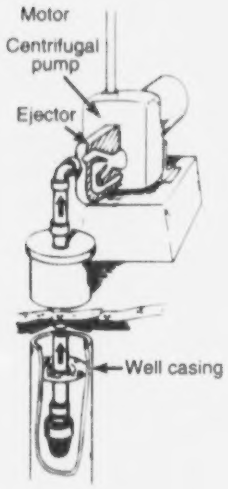
a. ____________________ b. ____________________

Written Test



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c. ______________________________

5. Distinguish among the operating principles of pumps used for private water systems by placing a "P" next to the description(s) of piston pumps, a "C" next to the description(s) of centrifugal pumps and a "J" next to the description(s) of jet pumps.

_______ a. Water is supplied to the jet nozzle under pressure; water surrounding the jet stream is lifted and carried through the pipe as a result of the jet action.

_______ b. With the single acting type, suction stroke draws water into the cylinder, and discharge stroke pushes water into the discharge pipe.

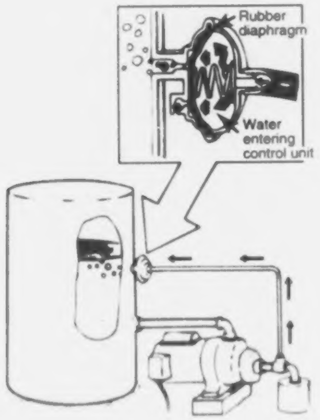
_______ c. An L-shaped pipe, completely filled with water and rotated rapidly, will pump water out of a bucket.

_______ d. In a manufactured pump, the lateral arms are replaced with an impeller.

_______ e. With the double acting type, movement of the plunger to the right pulls water from the well into the left chamber, and water is forced out of the right chamber; plunger movement to the left forces water out of the left chamber, and water is pulled from the well into the right chamber.

Written Test

6. Identify the following pump controls used on private water systems.



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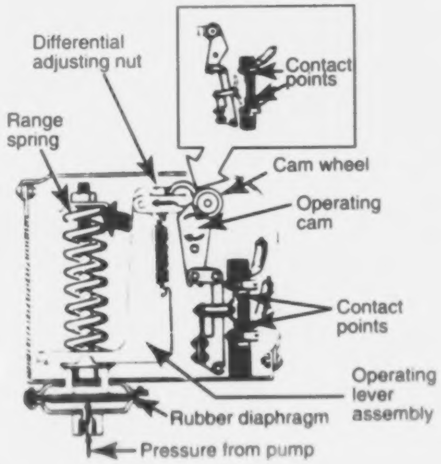
a. ______________________________



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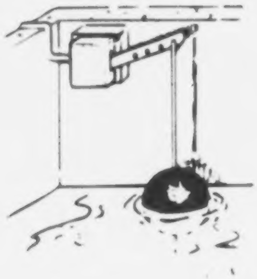
b. ______________________________



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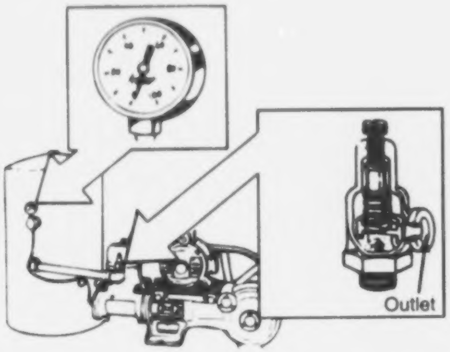
c. ______________________



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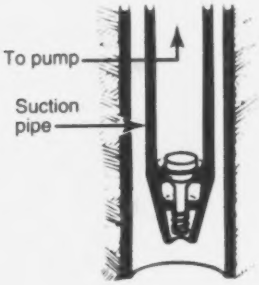
d. ______________________

e. ____________________



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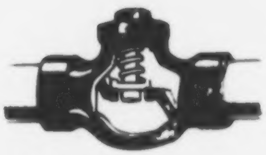
f. ______________________________



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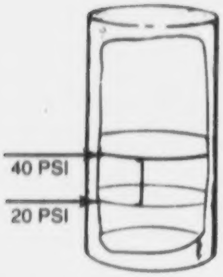
g. ______________________________

Written Test



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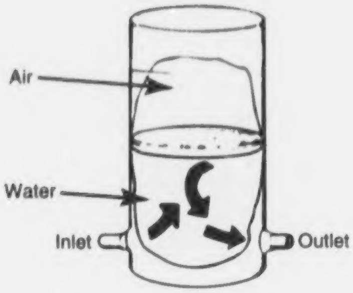
h. ______________________________



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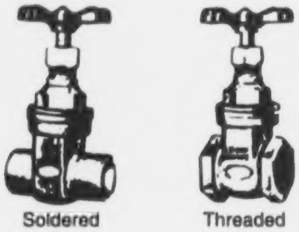
i. ______________________________



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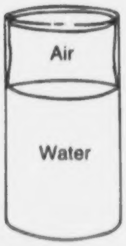
j. ______________________________



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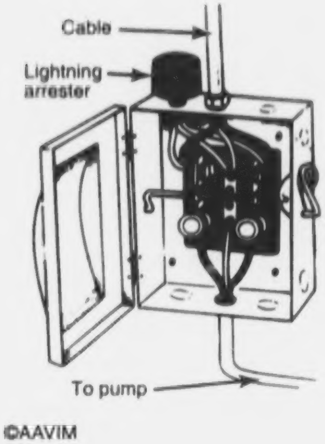
k. ______________________________



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l. ______________________________

Written Test

7. Select true statements concerning the applications of various pump controls on private water systems by placing an "X" next to the true statements.

_______ a. A pump must be fused separately on an electrical control box.

_______ b. A local control switch should be placed near the pump for manual off-on operation.

_______ c. Most pressure switches are factory set at 60–80 lbs. pressure.

_______ d. A float switch controls pump operation to determine necessary pressure.

_______ e. The air volume control keeps air from being absorbed into the water.

_______ f. Pressure gauges indicate storage tank pressures.

_______ g. A globe valve should be used in pump installations to ensure maximum water flow.

_______ h. Gate valves keep the suction pipe filled with water.

_______ i. If a pressure gauge is installed, a pressure switch is not necessary.

_______ j. An air volume control controls amount of air in pressure tank system.

_______ k. Floating air seals help to lower the air absorption rate in pressure tanks.

_______ l. The pressure switch controls pump operation to fill a gravity storage tank.

Permission to duplicate this test is granted.

Private Water Systems
Unit 1-E

Answers to Written Test

1. a. 7
   b. 9
   c. 1
   d. 8
   e. 10
   f. 2
   g. 11
   h. 6
   i. 3
   j. 14
   k. 4
   l. 12
   m. 13
   n. 5

2. a, c, e, f

3. Any six of the following:
   - Leaking sewer lines
   - Houses treated for termite control
   - Septic tanks
   - Leach (absorption) fields
   - Barnyards and livestock feedlots
   - Flooded land
   - Unsealed wells
   - Leaking underground fuel tanks
   - Waste disposal sites

4. a. Centrifugal
   b. Piston (reciprocating)
   c. Jet

5. a. J
   b. P
   c. C
   d. C
   e. P

6. a. Air volume control
   b. Pressure switch
   c. Float switch
   d. Pressure gauge
   e. Pressure relief valve
   f. Foot valve
   g. Spring-loaded check valve
   h. Precharged tank
   i. Floating air seal
   j. Gate valves
   k. Sealed-in air chamber
   l. Electrical control box (Switch box)

7. a, b, f, j, k

Private Water Systems
Unit 1-E

Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Assignment Sheet Rating

Assignment Sheet 1—Compute the Cost for Plumbing Supplies Rating ______

Comments: ______________________________________

____

Job Sheet Rating

Job Sheet 1—Install a Pump and Controls According to Manufacturer's Specifications Rating ______

Comments: ______________________________________

____

Written Test Scores

Pretest ________ Posttest ________ Other ________

Other ______________________________________

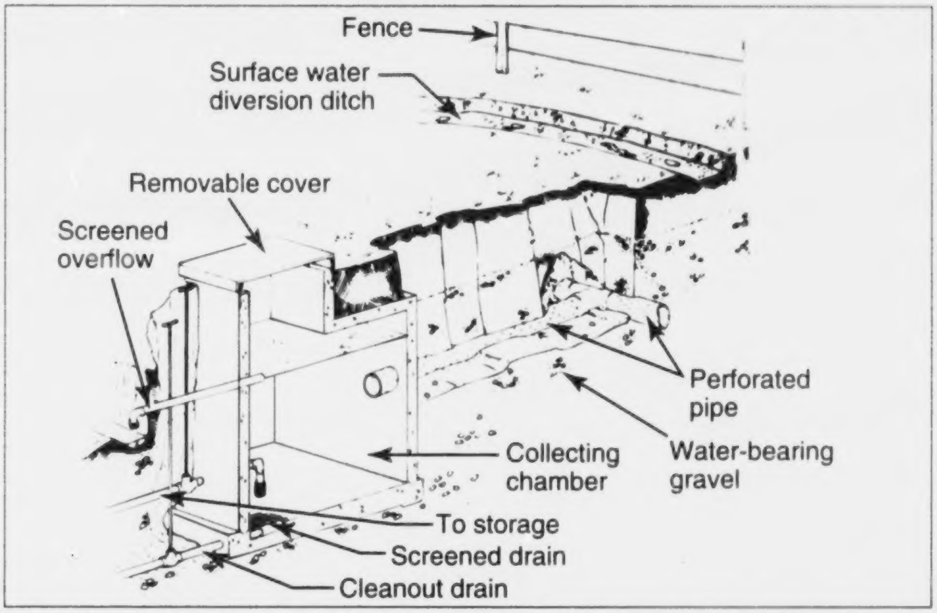
____

Teacher Signature ______________________ Date __________

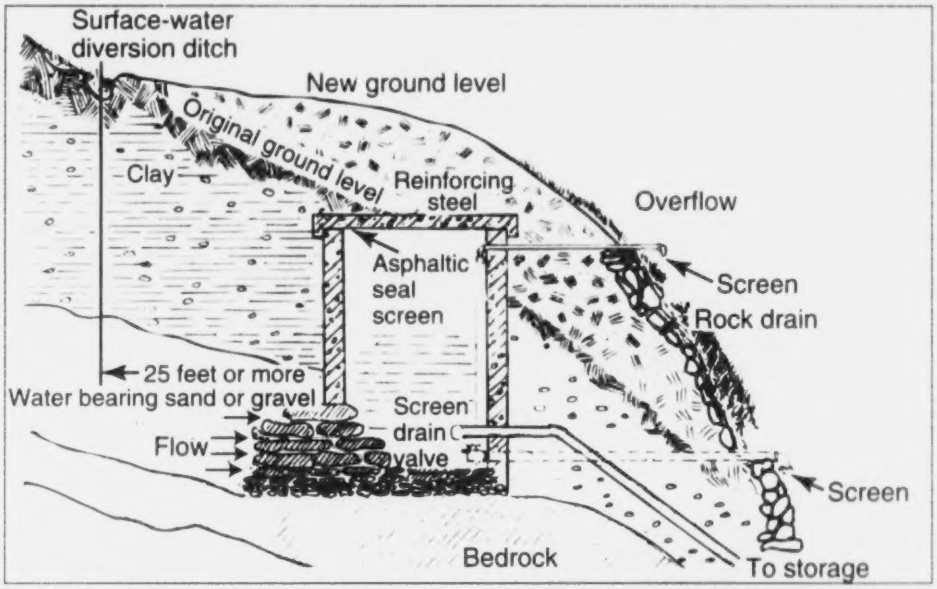
Student Signature ______________________ Date __________

Permission to duplicate this form is granted.

Protected Springs



A design for collecting water from a spring that provides protection against surface pollution and provides a means for entering and cleaning the collecting chamber



Protection of spring from surface contamination

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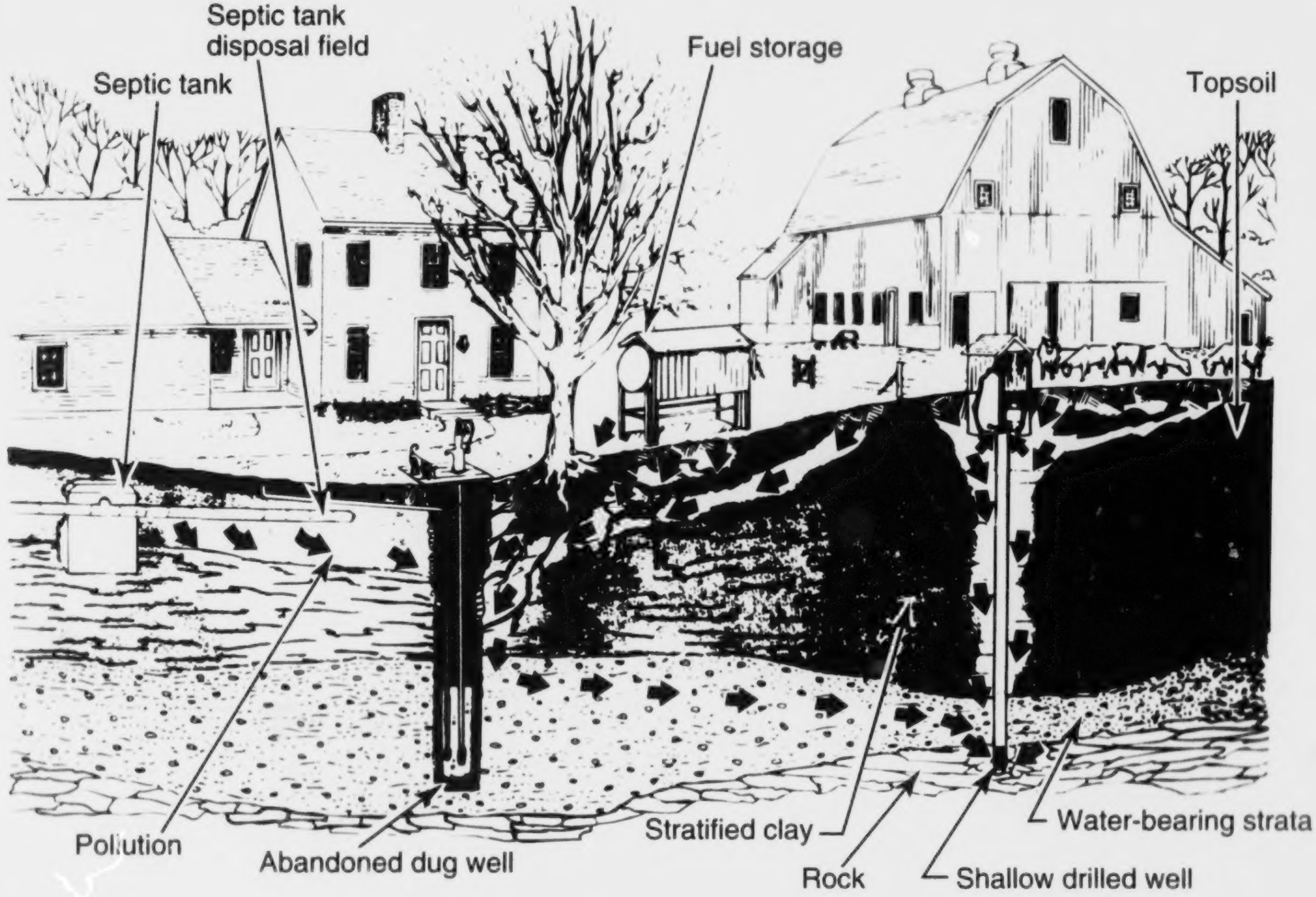
TM 1

Contamination of Water Supplies



Residential Plumbing, Unit 1-E
Teacher Page 19

TM 2

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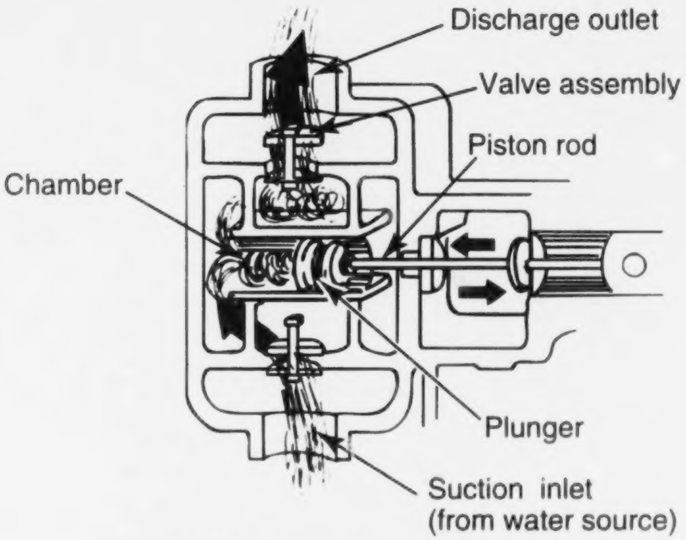
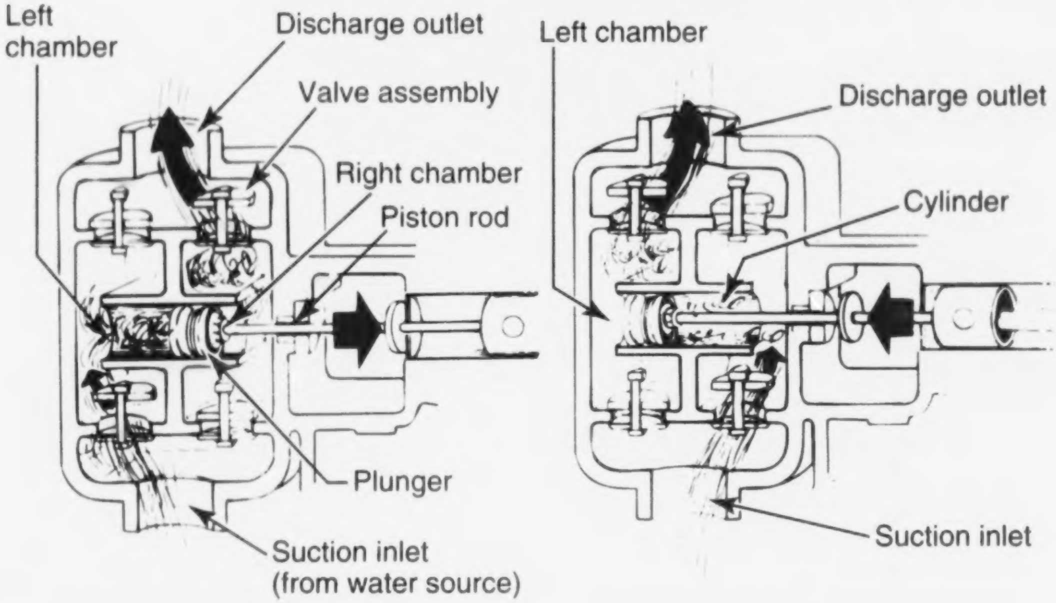
Operation of a Piston (Reciprocating) Pump



Single Acting Piston

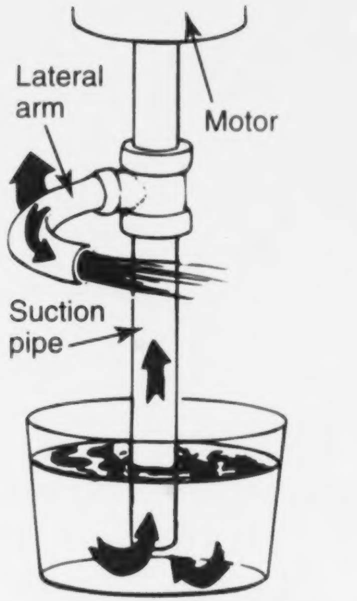


Movement of plunger to the right

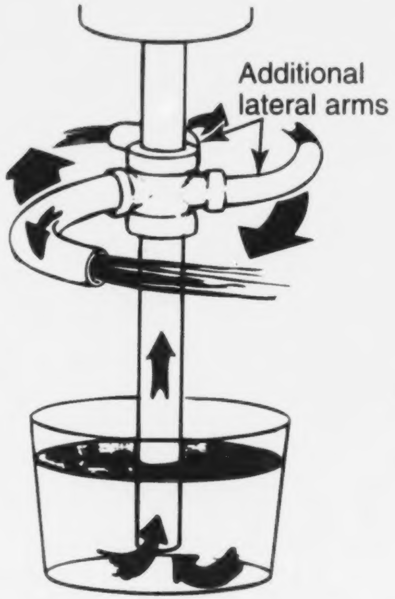
Movement of plunger to the left

Double Acting Piston

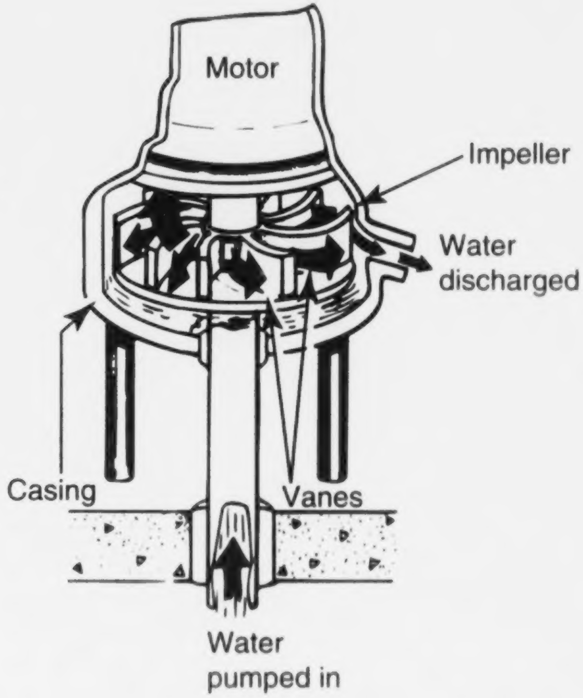
Operation of a Centrifugal Pump



L-shaped pipe rotated rapidly will pump water out of a bucket.



More water can be pumped with addition of lateral arms.



Manufactured pump with impeller replacing lateral arms.

TM 4

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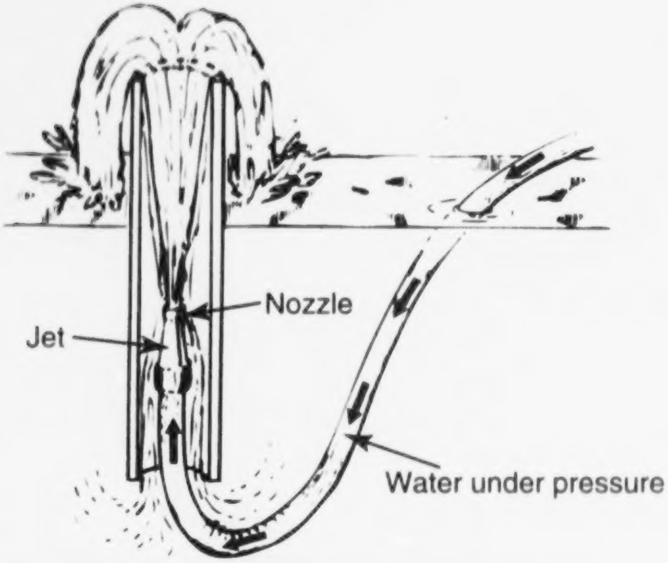
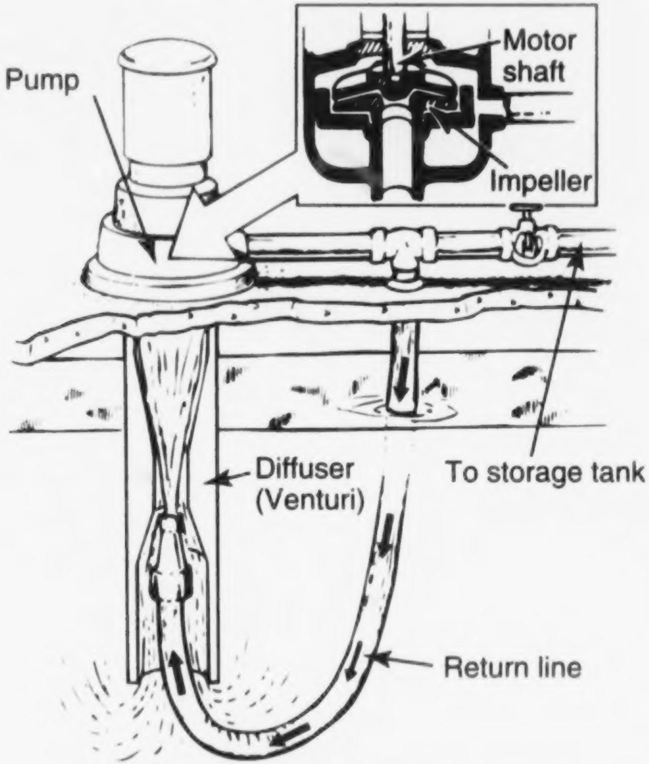
Operation of a Jet Pump



Water is supplied to jet nozzle under pressure. Water surrounding the jet stream is lifted and carried up the pipe as a result of jet action.



Jet used with a centrifugal pump.

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Septic Systems
Unit 2-E

Unit Contents

Teacher Components **Page**

Suggested Activities .3
Written Test .7
Answers to Written Test .11
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Transparency Masters
  1—Components of Private Sewage Disposal Systems .15
  2—Construction Methods and Materials .17

Student Components **Page**

Objective Sheet .E-25
Information Sheet .E-27
Job Sheet 1—Install a Septic Tank .E-33

340

Septic Systems
Unit 2-E

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
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Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000.* These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Provide students with local plumbing code books and discuss the construction details of septic tanks. **(Reading; listening; and information acquisition, evaluation, and interpretation)**
- Discuss the construction of a subsurface tile system. **(Listening; seeing things in the mind's eye; and systems interrelationships)**
- Contact the sanitarian from the local board of health to address the class on the percolation test procedure. **(Listening; seeing things in the mind's eye; reasoning; and information acquisition and evaluation)**
- Invite a local engineer or sanitarian to discuss the minimum standards, location, and design of residential lagoons. **(Listening; reasoning; information acquisition and evaluation; and systems interrelationships)**
- Visit the site of a septic tank installation. Discuss the installation and maintenance procedures with the installer. **(Listening; reasoning; systems interrelationships; and maintenance and troubleshooting)**
- Invite an employee of the county health department to discuss advantages and disadvantages of various types of private waste treatment systems. **(Listening; decision making; and reasoning)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.
- Make copies of the written test. Add or modify test items as needed.
- Give and evaluate written test.
- Compile the job sheet rating and written test scores on the Unit Evaluation Form. Include any additional assignments or supplemental activities that should be part of the unit evaluation.
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- Blankenbaker, Keith E. *Modern Plumbing*. South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.
- *Manual for Septic Tank Practice*. Public Health Service Publication No. 526. Washington, D.C.: U.S. Government Printing Office.

Suggested Supplemental Resources

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- Massey, Howard C. *Plumber's Handbook*. 5th ed. Carlsbad, CA: Craftsman Book Company, 1994.

Septic Systems
Unit 2-E

Written Test

Name ______________________ Date __________ Score __________

1. Match the terms on the right with the correct definitions.

_______ a. Destructive action of bacteria on organic matter

_______ b. A waterproof tank in a private sewage disposal system that promotes the growth and reproduction of bacteria in order to break up and decompose organic matter

_______ c. A test to determine the ability of the soil to absorb water

_______ d. A piping installation designed to disperse the septic tank discharge into the soil to be evaporated or absorbed

_______ e. A small tank taking the immediate discharge of the septic tank and distributing it in two or more directions

_______ f. The clear liquid discharge which flows out of a septic tank

_______ g. Pipe with holes in the side which allow liquid to be released into the ground

_______ h. A pit or well constructed of brick, stone, or block, without any masonry (cement bond), used to receive sewage discharge from a building

_______ i. Solids that settle to the bottom of a tank or pit

_______ j. Bacteria that live and grow in the absence of oxygen

_______ k. Bacteria that live and grow in the presence of oxygen

_______ l. Small pond taking the effluent from the septic tank when leach field drainage is insufficient

_______ m. A perforated masonry tank used to disperse the effluent from a septic tank

1. Percolation test
2. Distribution box
3. Effluent
4. Cesspool
5. Sludge
6. Septic
7. Aerobic bacteria
8. Lagoon
9. Anaerobic bacteria
10. Septic tank
11. Leach field
12. Perforated pipe
13. Leaching pit

Written Test

2. Complete the following statements concerning the operation of a septic system by filling in the blanks with the correct answers.

   a. The ______________________________ receives the discharge from soil pipes that extend beyond building walls.

   b. ______________________________ settle to the bottom of the tank.

   c. ______________________________ decompose the solids and clarify the liquid effluent.

   d. The effluent leaves the septic tank by gravity and enters the ____________________.

   e. The effluent is dispersed into the soil, sand, and/or gravel to be evaporated at the ground surface or to be drained into the ______________________________.

3. Select true statements concerning the basic design of a septic system by placing an "X" next to the true statements.

   _______ a. The sewage disposal system should consist of a septic tank with effluent discharging into a subsurface tile system.

   _______ b. All waste water must be connected to the disposal system, except laundry and kitchen wastes.

   _______ c. Septic systems are designed for a maximum usage of 8,000 gallons per month for 2- or 3-bedroom residences, and 10,000 gallons per month for 4-bedroom residences.

   _______ d. All parts of the disposal system should be located a least 50′ from any water supply when the ground slopes from the water well and conditions are favorable.

   _______ e. All parts of the sewage disposal system except the septic tank and connecting house sewer (i.e., subsurface tile, distribution, or retention boxes) should be located at least 10′ from dwellings, garages, or other structures, and 15′ from water lines.

   _______ f. The septic tank should be located a minimum of 20′ from dwellings, garages, or other structures.

   _______ g. All parts of the system should be located a minimum of 25′ from property lines under favorable drainage and soil conditions.

4. List four septic tank construction materials.

   a. ____

   b. ____

   c. ____

   d. ____

Written Test

5. Select true statements concerning septic tank care by placing an "X" next to the true statements.

_______ a. A septic tank should be cleaned every year.

_______ b. A septic tank should be checked every five years to determine if cleaning is necessary.

_______ c. A piece of lumber 1″ x 2″ x 8′ wrapped and nailed with cloth toweling may be lowered into the septic tank to determine when the septic tank needs to be cleaned.

_______ d. The sludge will eat away the cloth toweling on the lumber, denoting the total depth of sludge accumulation.

_______ e. When the depth of the sludge exceeds 6″, it is time to have the septic tank cleaned by a licensed septic tank cleaner.

_______ f. A gallon of sludge should be left in the tank after cleaning as a bacterial starter.

_______ g. The normal use of bleaches, detergents, and drain cleaners does not harm or interfere with the operation of the system.

Permission to duplicate this test is granted.

Septic Systems
Unit 2-E

Answers to Written Test

1. a. 6
   b. 10
   c. 1
   d. 11
   e. 2
   f. 3
   g. 12
   h. 4
   i. 5
   j. 9
   k. 7
   l. 8
   m. 13

2. a. Septic tank
   b. Organic solids (sludge)
   c. Bacteria
   d. Leaching field
   e. Ground

3. a, c, d, e

4. Any four of the following:
   - Reinforced (wire mesh) concrete
   - #12 gauge steel, coated with bituminous material
   - Cement blocks
   - Fiberglass
   - Reinforced plastic

5. c, f, g

Septic Systems
Unit 2-E

Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Job Sheet Rating

Job Sheet 1—Install a Septic Tank Rating ______

Comments: ______________________________________

____

Written Test Scores

Pretest ________ Posttest ________ Other ________

Other ______________________________________

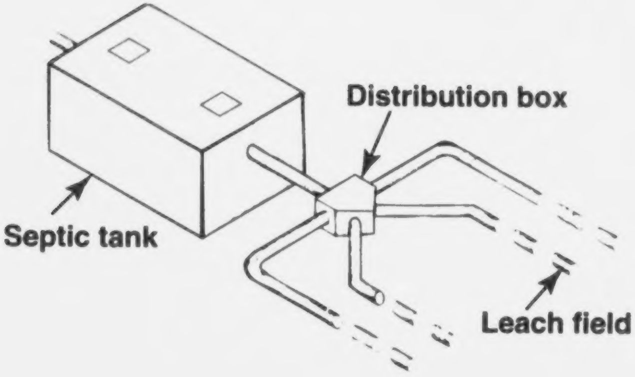
____

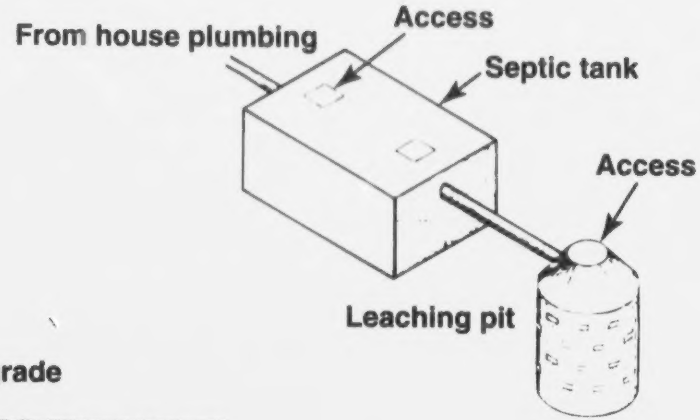
Teacher Signature ______________________ Date __________

Student Signature ______________________ Date __________

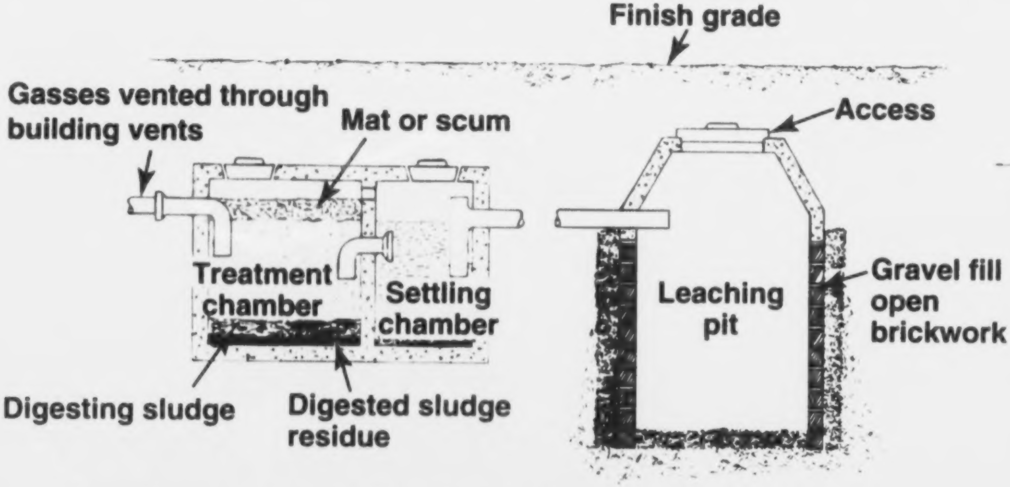
Permission to duplicate this form is granted.

Components of Private Sewage Disposal Systems

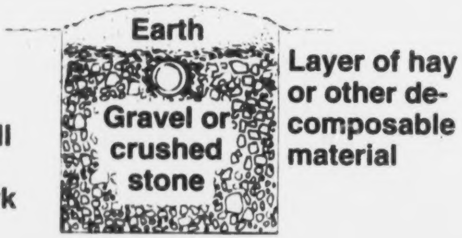




Cesspool



Two-Compartment Septic Tank

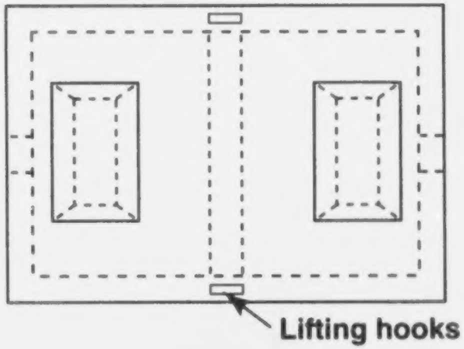


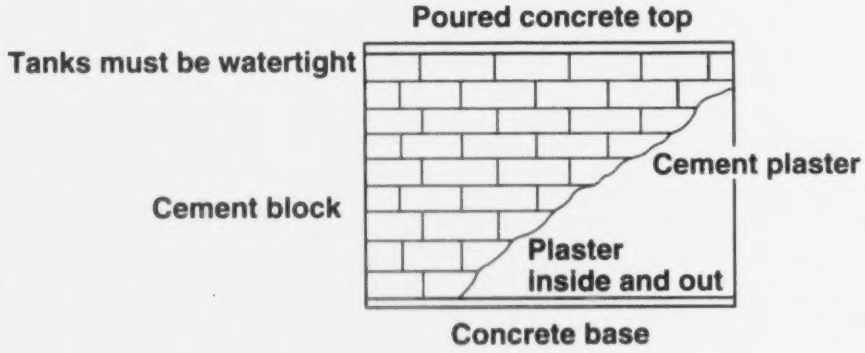
Cross Section of Leach Field

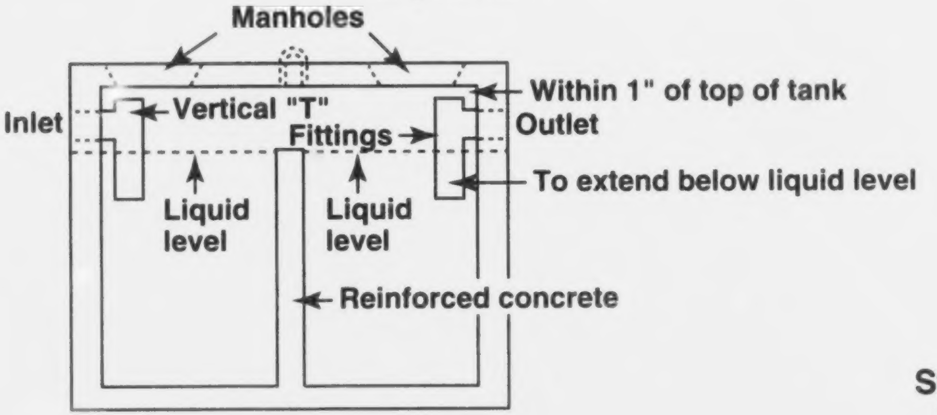
Residential Plumbing, Unit 2-E
Teacher Page 15

TM 1

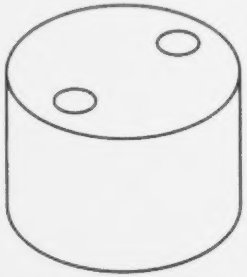
Construction Methods and Materials







Typical Precast Concrete Tank
3000 lbs. Minimum Strength Concrete



Steel Tank Coated with
Bituminous Material

Water Treatment
Unit 3-E

Unit Contents

Teacher Components **Page**

Suggested Activities 3
Written Test 7
Answers to Written Test 11
Unit Evaluation Form 13

Transparency Masters

1—Chlorine Methods of Disinfecting Water 15
2—Chlorine Methods of Disinfecting Water (Continued) 17
3—Pasteurization Method of Disinfecting Water 19
4—Ultraviolet Light Method of Disinfecting Water 21
5—Water Softener 23
6—Means of Controlling Water Quality 25
7—Means of Controlling Water Quality (Continued) 27
8—Means of Controlling Water Quality (Continued) 29
9—Means of Controlling Water Quality (Continued) 31

Student Components **Page**

Objective Sheet E-35
Information Sheet E-37
Job Sheet 1—Prepare a Water Sample for Analysis by a State Testing Laboratory E-49

Water Treatment
Unit 3-E

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resources Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Make transparencies from the transparency masters included in this unit.
- Review "Instructions for Evaluating Student Performance."
- Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

Unit Introduction

- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss and demonstrate the job sheet. Make sure all required tools, equipment, and materials are available. Review criteria for evaluation of this activity.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Take a field trip to a town water treatment plant. **(Listening; and system interrelationships)**
- Have a manufacturer's representative address the class concerning equipment used to treat water. **(Listening; and reasoning)**
- Show an automatic water softener to the class and explain how it works. **(Listening; reasoning; problem solving; and system interrelationships)**
- Have a county health representative visit the class to discuss various tests performed on water samples to determine whether or not contamination is present. **(Science; listening; reasoning; and problem solving)**
- Demonstrate the use of a water testing kit. **(Science; listening; and reasoning)**
- Arrange to visit a local water utility plumbing supply company, and ask the company's representative to discuss the water treatment devices they sell. **(Listening; decision making; reasoning; and material selection)**
- Ask the local water utility company for copies of recent water quality analyses. Have students compare the results from these tests with EPA standards. **(Reading; science; and reasoning)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.
- Make copies of the written test. Add or modify test items as needed.
- Give and evaluate written test.
- Compile the job sheet rating and written test score on the Unit Evaluation Form. Include any additional assignments or supplemental activities that should be part of the unit evaluation.
- Meet individually with students to evaluate their progress through this unit of instruction and indicate to them possible areas of improvement.
- Reteach and retest as required.

Suggested Activities

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

Resources Used in Developing This Unit

- Barclay, Leney. *Residential Plumbing.* Revised by Hank Johnson. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1985.
- Henderson, G. E. *Planning for an Individual Water System.* Winterville, GA: American Association for Vocational Materials, 1982.

Suggested Supplemental Resources

- Blankenbaker, Keith E. *Modern Plumbing.* South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.
- Massey, Howard C. *Plumber's Exam.* 5th ed. Carlsbad, CA: Craftsman Book Company, 1996.
- Massey, Howard C. *Plumber's Handbook.* 5th ed. Carlsbad, CA: Craftsman Book Company, 1994.

Water Treatment
Unit 3-E

Written Test

Name ________________________________ Date ______________ Score ______________

1. Match the terms on the right with the correct definitions.

________ a. Water that is relatively free from harmful bacteria, viruses, parasites, and radiation

________ b. A source which makes water unwholesome, impure, or undesirable for use or consumption

________ c. Physical sources that contaminate water

________ d. Correcting quality problems of water supply

________ e. Weakening or destroying by chemical action

________ f. Total amount of chlorine added to water in parts per million (ppm)

________ g. Chlorine used up in reaction to organic matter

________ h. Amount of chlorine solution that is left over after its killing action is "used up"

________ i. The passage of fresh water through a special membrane into the side of a tank containing salt water

________ j. By applying pressure to water on the side containing salt or hardness particles, water is forced to move back through the membrane, cleansing it of soluble materials

________ k. Atom or group of atoms that carry an electrical charge

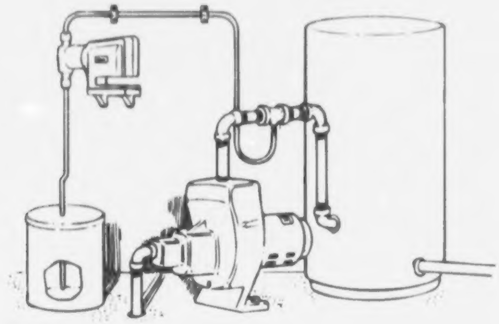
________ l. The process of exchanging the hard calcium and magnesium ions for soft sodium ions

________ m. Sand-like water softening material

1. Ion
2. Demand
3. Pollution
4. Zeolite
5. Safe water
6. Osmosis
7. Residual
8. Corrosive
9. Ion exchange
10. Water conditioning
11. Reverse osmosis
12. Dosage
13. Contamination

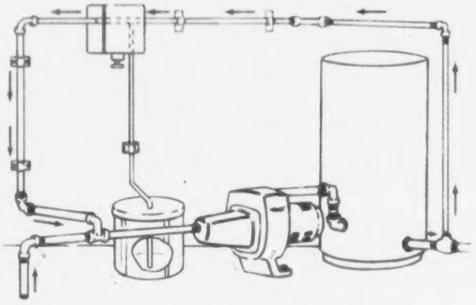
Written Test

2. Identify the following methods of disinfecting water.



©AAVIM

a. ______________________________



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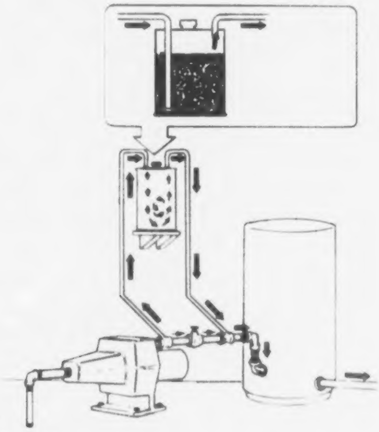
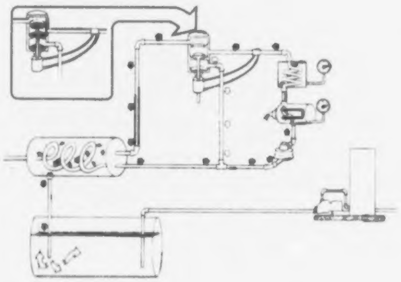
b. ______________________________



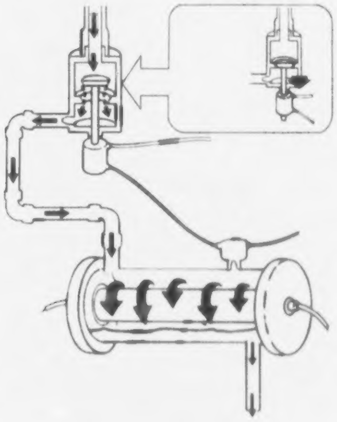
©AAVIM

c. ______________________________



©AAVIM

d. ______________________________



e. ______________________________

Written Test

3. State the probable causes of the following poor water quality symptoms.

a. Hardness

- Sticky curd forms when soap is added to water
- Causes well-recognized ring in bathtub
- The harder the water, the more soap is required to form suds
- Glassware appears streaked and murky
- Hard, scaly deposits form inside metal pipes
- Skin roughens from washing

Probable cause: ________________________________

b. Red water

- Red stains appear on clothes and porcelain plumbing fixtures
- Causes corrosion of steel pipes
- Water has metallic taste
- Freshly-drawn water sometimes appears clear at first, but after exposure to air, rust particles form and settle to bottom of container
- Red slime develops in toilet tanks

Probable cause: ________________________________

c. Brownish-black water

- Fixtures stain brownish-black
- Fabrics stain black
- Coffee and tea have bitter taste

Probable cause: ________________________________

d. Acidity

- "Eats away" copper and steel parts on pump, piping, tank, and fixtures
- If copper or brass is being "eaten," water may leave green stains on plumbing fixtures under a dripping faucet
- If water contains iron, iron-removal methods are less effective

Probable cause: ________________________________

e. "Rotten egg" odor and flavor

- "Eats away" copper and steel parts on pump, piping, tank, and fixtures
- If sulfur and iron are both present in water, finely-divided black particles may develop; commonly called "black water"
- Not satisfactory for cooking

Probable cause: ________________________________

Written Test

f. Other off-flavor symptoms

- Water may taste bitter, oily, salty, or have a chlorine odor or taste

  Probable cause: ____

g. Turbidity

- Water with a dirty or muddy appearance

  Probable cause: ____

4. Match the poor water conditions on the right with the means used to control them.

_______	a.	Water softener or reverse-osmosis unit	1.	Iron
_______	b.	Phosphate feeder, ion-exchange units, oxidizing filters, and chlorinator-and-filter units	2.	Acid water
			3.	Manganese
_______	c.	Soda ash and caustic-soda feeder	4.	Hard water
_______	d.	Activated-carbon filter (cartridge type or carbon-bed type)	5.	Turbidity
_______	e.	Open pond treatment or treatment systems such as sedimentation and filtering system, diatomite filter, and rapid sand filter	6.	Off-flavor

Permission to duplicate this test is granted.

Water Treatment
Unit 3-E

Answers to Written Test

1. a. 5
b. 13
c. 3
d. 10
e. 8
f. 12
g. 2
h. 7
i. 6
j. 11
k. 1
l. 9
m. 4

2. a. Pump chlorine method
b. Injector chlorine method
c. Tablet chlorine method
d. Pasteurization method
e. Ultraviolet light method

3. a. Any one of the following:
- Calcium and magnesium in the water
- Iron

b. Any one of the following:
- Dissolved iron (sometimes including manganese)
- Iron bacteria

c. Any one of the following:
- Manganese present, usually along with iron
- Manganese bacteria

d. Any one of the following:
- Water contains carbon dioxide picked up from air or from decaying vegetable matter that combines with water to form a weak acid.
- In rare instances, water may contain mineral acid such as sulfuric, nitric, or hydrochloric acids.

e. Any one of the following:
- Hydrogen-sulfide gas
- Sulfate-reducing bacteria
- Sulfur bacteria

f. Any one of the following:
- Extremely high mineral content
- Presence of organic matter
- Excess chlorine
- Water passing through areas containing salty or oily waste

g. Any one of the following:
- Silt
- Sediment
- Small organisms
- Organic matter

4. a. 4
b. 1 or 3
c. 2
d. 6
e. 5

Water Treatment
Unit 3-E

Unit Evaluation Form

Student Name ______________________________ Unit Rating ____________

Job Sheet Rating

Job Sheet 1—Prepare a Water Sample for Analysis
by a State Testing Laboratory Rating ______

Comments: ____

____

Written Test Scores

Pretest ________ Posttest ________ Other ________

Other ____

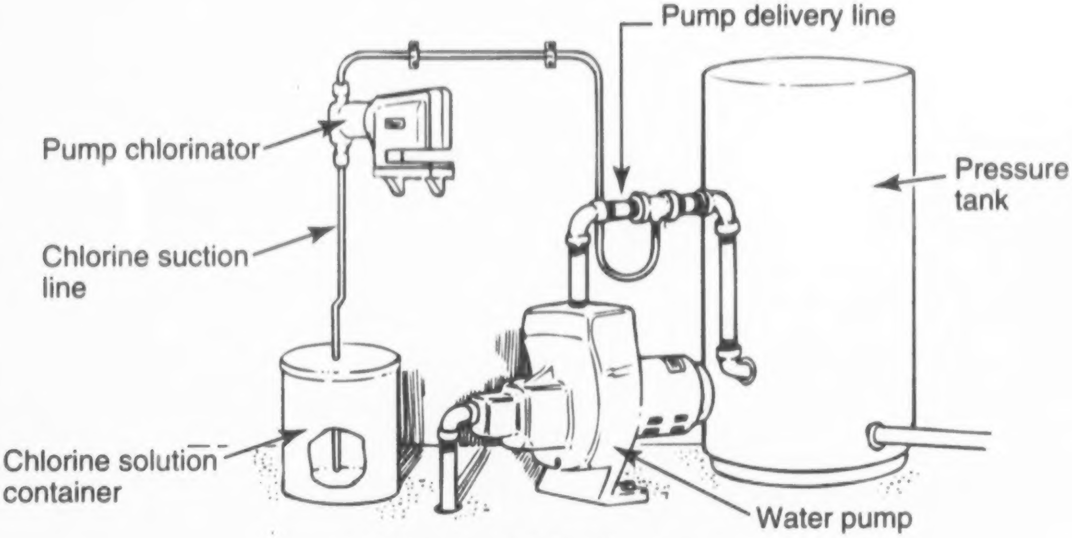
____

Teacher Signature ______________________________ Date ______________

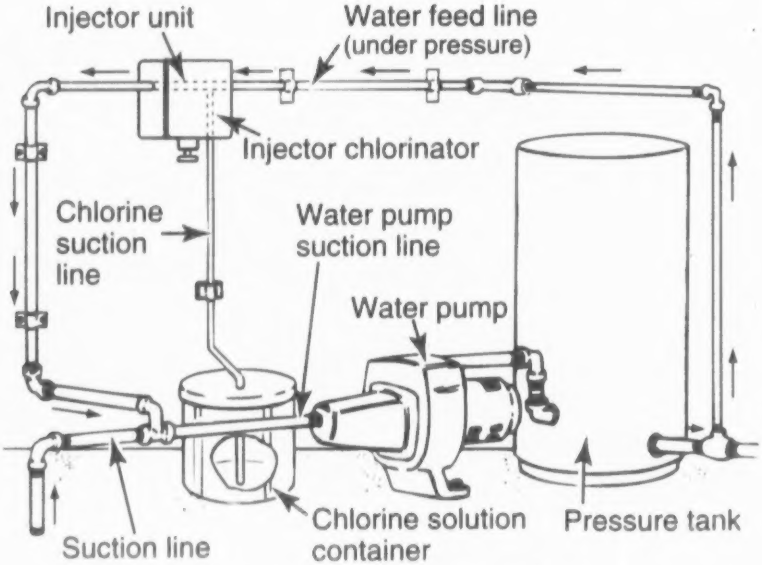
Student Signature ______________________________ Date ______________

Permission to duplicate this form is granted.

Chlorine Methods of Disinfecting Water



Pump Chlorinator

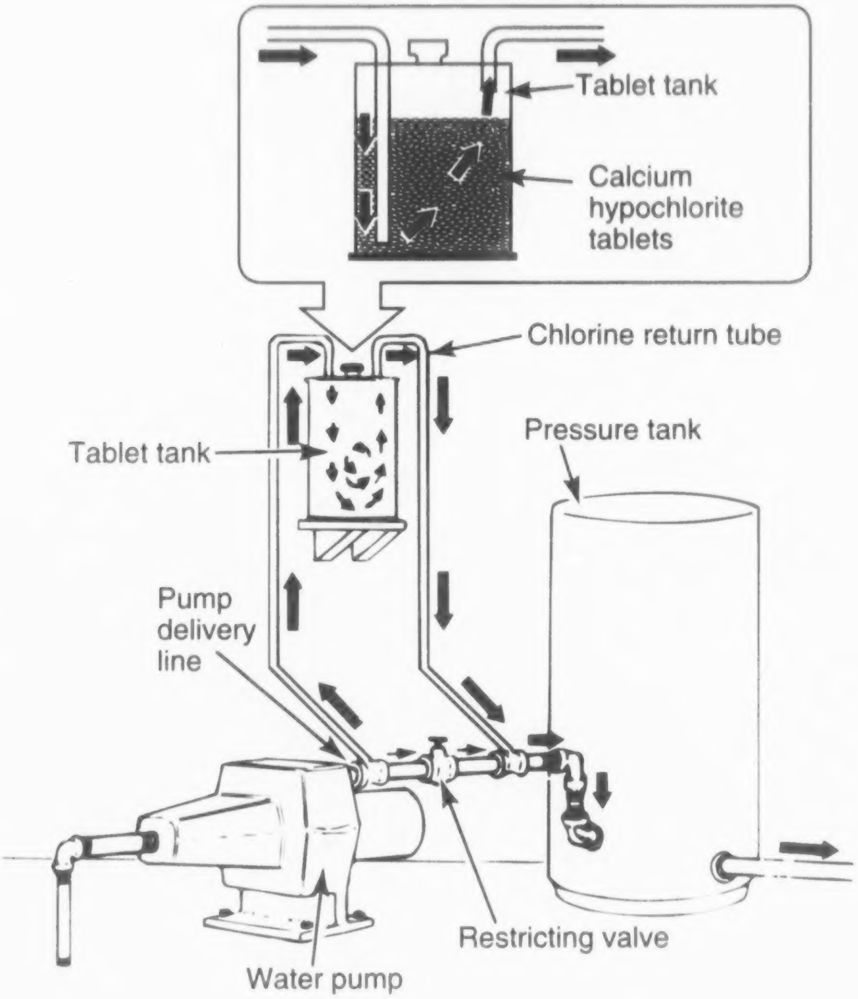


Injector Chlorinator

Used with permission of American Association for Vocational Instructional Materials from *Planning for an Individual Water System.*

Chlorine Methods of Disinfecting Water

(Continued)



Tablet Chlorinator

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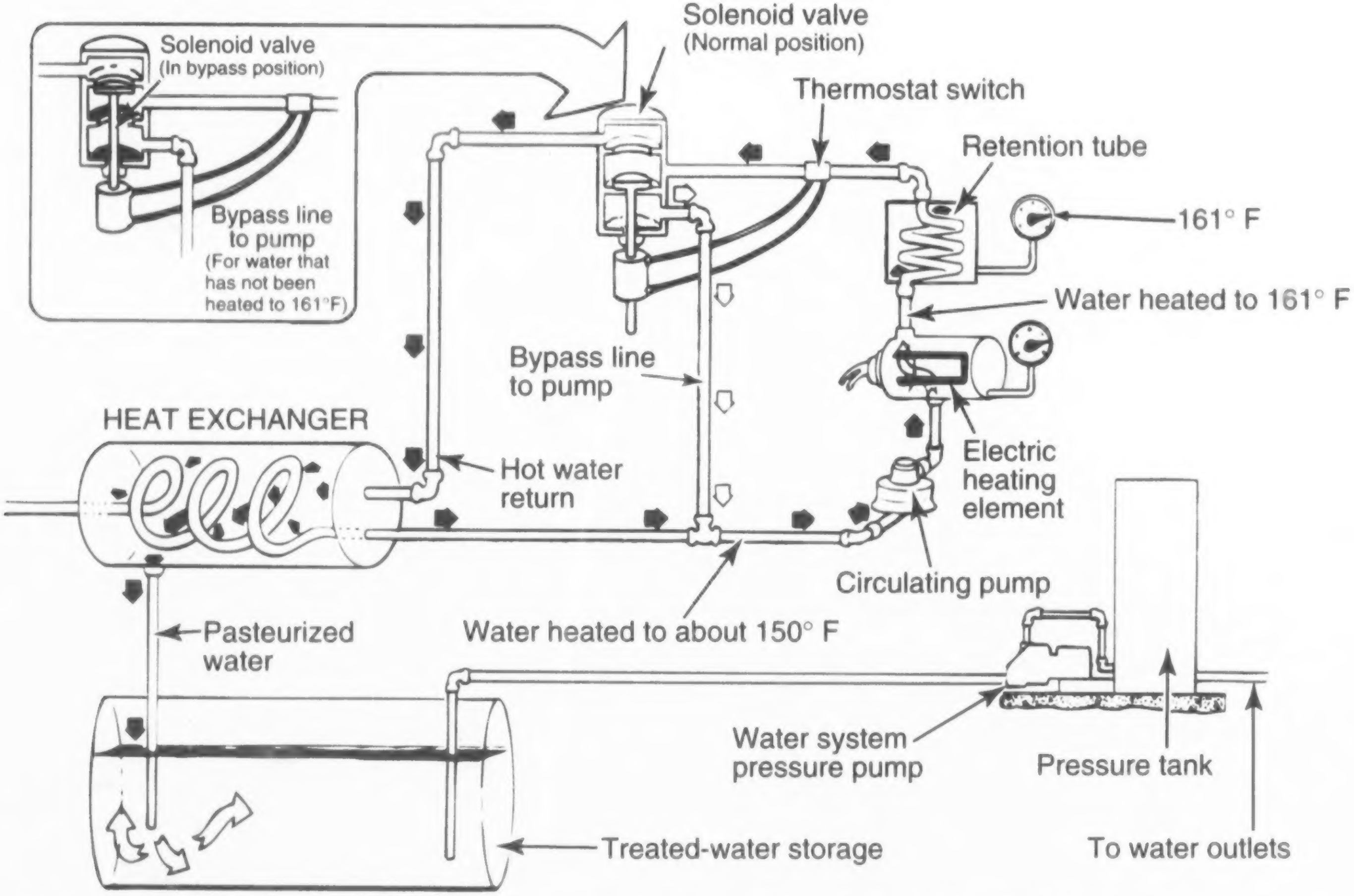
Pasteurization Method of Disinfecting Water



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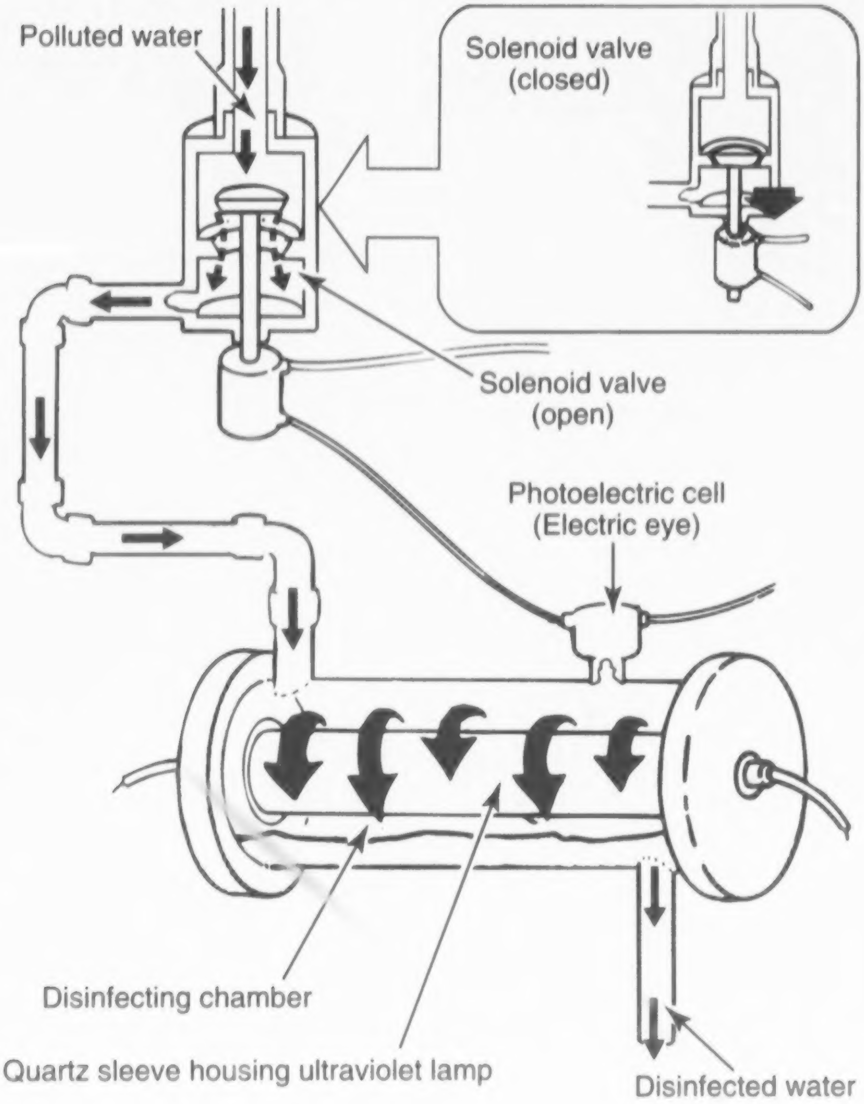
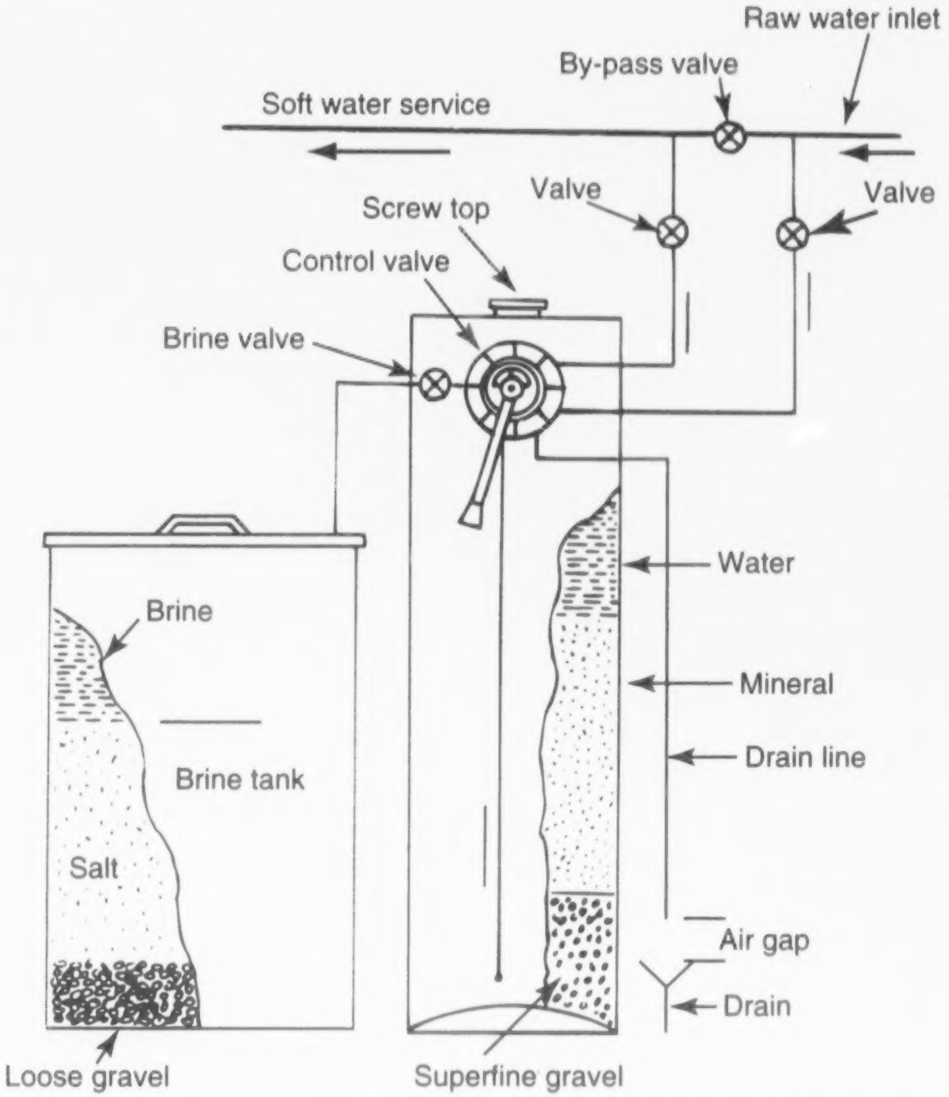
Residential Plumbing, Unit 3-E
Teacher Page 19

Ultraviolet Light Method of Disinfecting Water



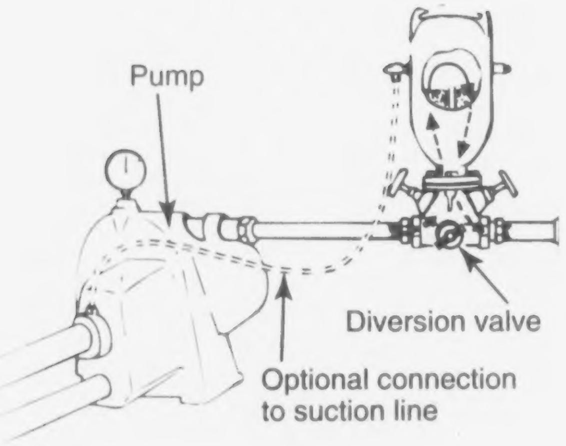
Water Softener



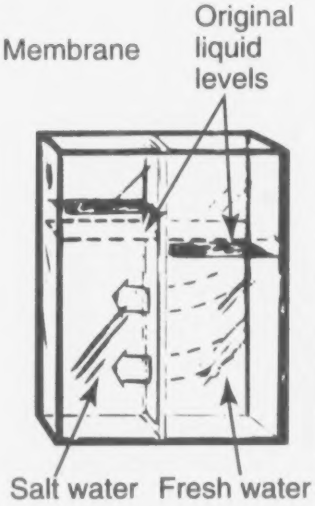
Used with permission of the Ontario Ministry of Colleges and Universities from *Steamfitting, Module D-1, Valves.*

Means of Controlling Water Quality

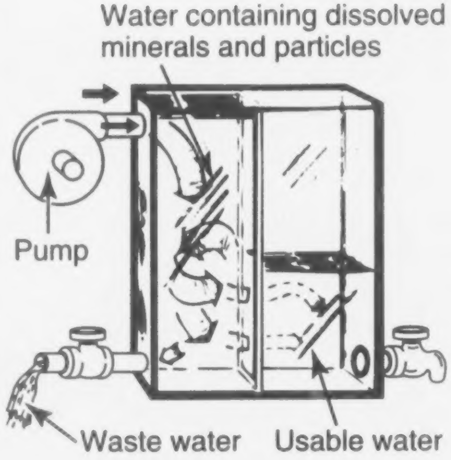
Residential Plumbing, Unit 3-E
Teacher Page 25



Phosphate feeder



Osmosis



Reverse Osmosis

TM 6

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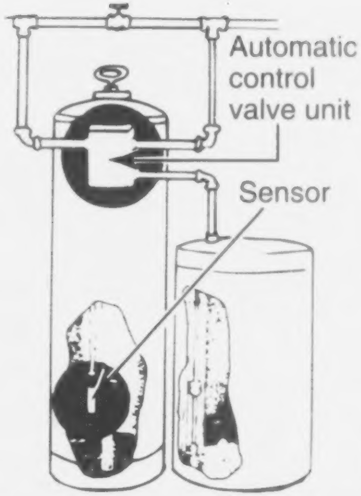
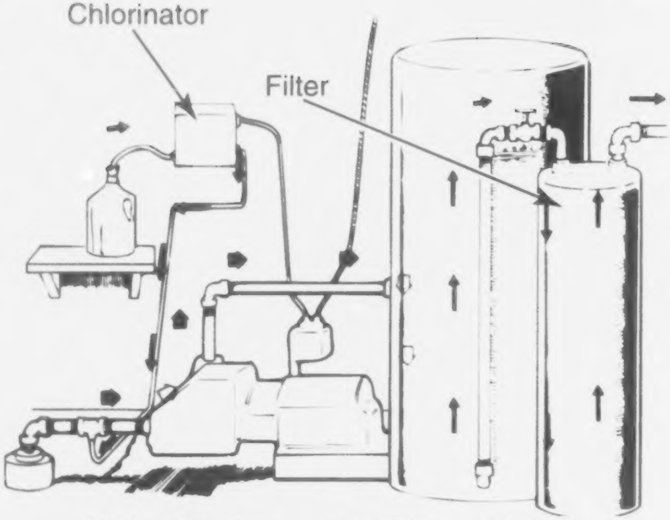
Means of Controlling Water Quality

(Continued)

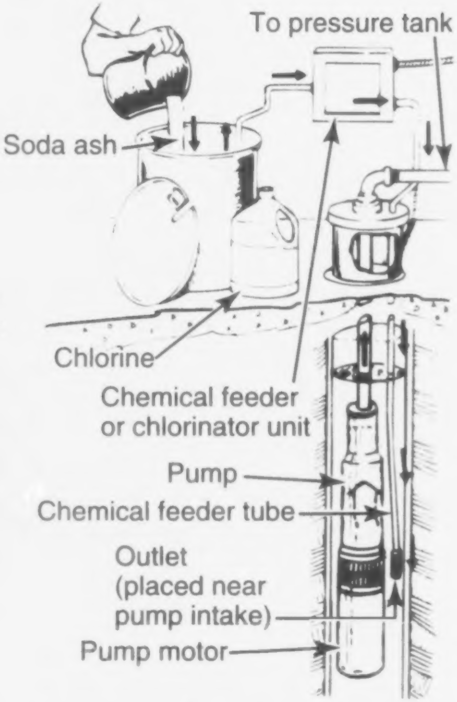
Residential Plumbing, Unit 3-E
Teacher Page 27



Ion Exchange Units



Chlorinator and Filter Units



Soda Ash or Caustic Soda Feeder

TM 7

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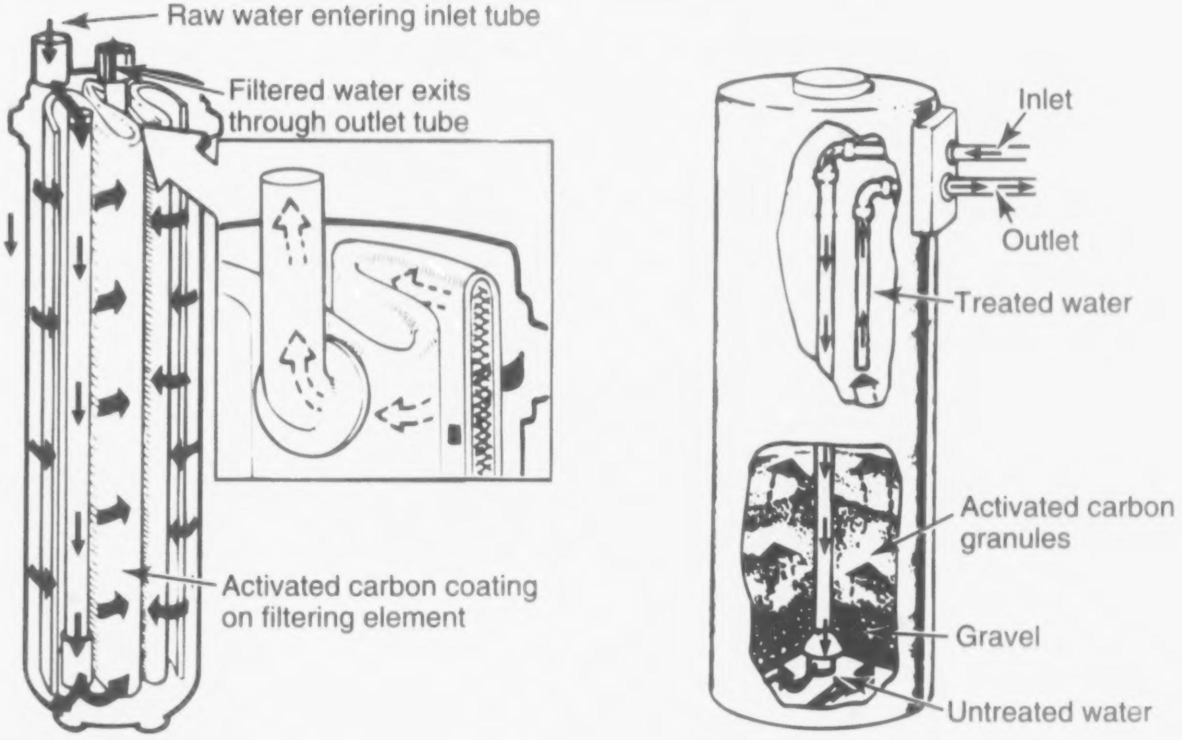
Means of Controlling Water Quality

(Continued)


Raw water entering inlet tube
Filtered water exits through outlet tube
Activated carbon coating on filtering element
Inlet
Outlet
Treated water
Activated carbon granules
Gravel
Untreated water

Cartridge Type

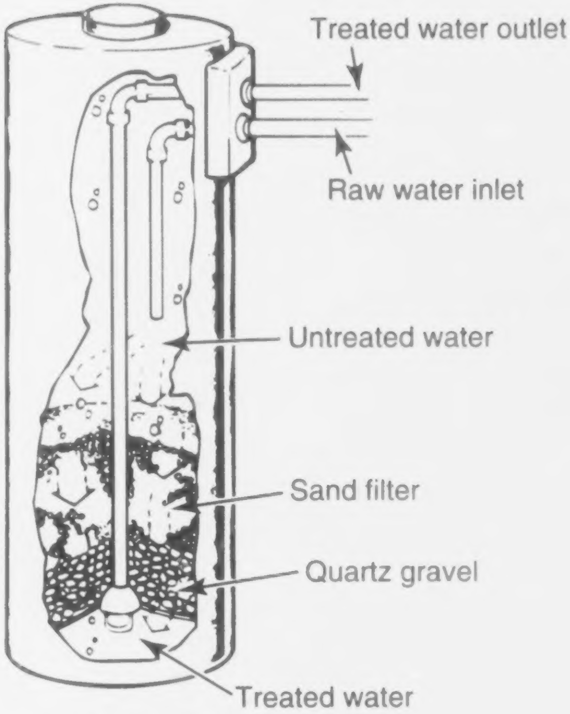
Carbon Bed Type

Activated Carbon Filters

Used with permission of American Association for Vocational Instructional Materials from *Planning for an Individual Water System.*

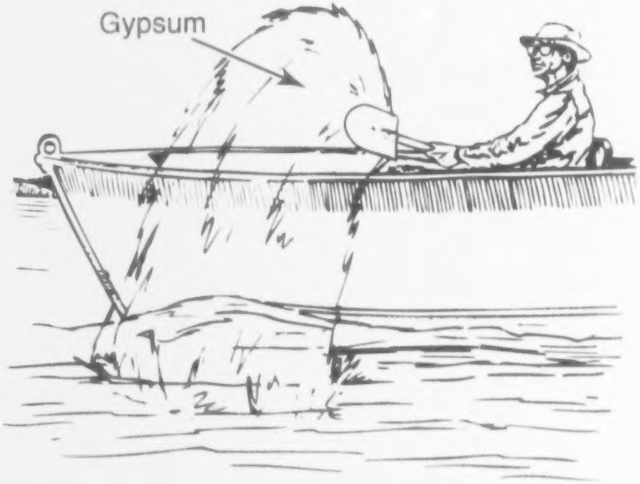
Means of Controlling Water Quality

(Continued)



Rapid Sand Filter

Used on the pressure side of a pump for filtering out suspended dirt particles



Open Pond Treatment

Gypsum may be applied to pond surface to clear up turbidity without killing fish or other marine life.

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Fuel Piping Systems
Unit 4-E

Unit Contents

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Answers to Assignment Sheet 1 7
Written Test 9
Answers to Written Test 13
Unit Evaluation Form 15

Student Components **Page**

Objective Sheet E-51
Information Sheet E-53
Assignment Sheet 1—Size a Gas Pipe for Residential Construction E-59
Job Sheet 1—Perform Leak Tests on Gas Supply Lines E-65

Fuel Piping Systems
Unit 4-E

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resources Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Review "Instructions for Evaluating Student Performance."
- Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

Unit Introduction

- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss the assignment sheet. Review with students the criteria for evaluation of this activity.
- Discuss and demonstrate the job sheet. Make sure all required tools, equipment, and materials are available. Review criteria for evaluation of this activity.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000.* These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Conduct a field trip to a construction site where the fuel piping system is being installed. **(Listening; learning how to learn; and system interrelationships)**
- Provide students with a copy of the local fuel piping code and have them answer questions using the code. **(Reading; problem solving; and reasoning)**
- Have a local gas company representative speak to the class about gas piping systems and code requirements. **(Listening; and reasoning)**
- Provide additional problems for the students to practice sizing gas pipes as shown in Assignment Sheet 1. **(Reading; mathematics; problem solving; and reasoning)**
- Demonstrate the use of gas piping testing devices. (**Listening; reasoning; technology application; and maintenance and troubleshooting)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.
- Make copies of the written test. Add or modify test items as needed.
- Give and evaluate written test.
- Compile the assignment sheet rating, the job sheet rating, and written test scores on the Unit Evaluation Form. Include any additional assignments or supplemental activities that should be part of the unit evaluation.
- Meet individually with students to evaluate their progress through this unit of instruction and indicate to them possible areas of improvement.
- Reteach and retest as required.

Suggested Activities

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

Resources Used in Developing This Unit

- Barclay, Leney. *Residential Plumbing*. Revised by Hank Johnson. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1985.
- Blankenbaker, Keith E. *Modern Plumbing*. South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.
- *The BOCA Basic/National Mechanical Code*. Country Club Hills,IL: Building Officials and Code Administrators International, Inc.
- *National Fuel Gas Code*. Arlington: American Gas Association.
- *Standard Gas Code*. Birmingham, AL: Southern Building Code Congress International, Inc.

Suggested Supplemental Resources

Print Media

- Massey, Howard C. *Plumber's Exam*. 5th ed. Carlsbad, CA: Craftsman Book Company, 1996.
- Massey, Howard C. *Plumber's Handbook*. 5th ed. Carlsbad, CA: Craftsman Book Company, 1994.

Fuel Piping Systems
Unit 4-E

Answers to Assignment Sheet 1—Size a Gas Pipe for Residential Construction

1. Maximum gas demand for barbecue grill (from Table 1) = 50,000 BTU. Convert BTU to CFH.

   $$\begin{array}{r} 45.4 \\ 1100\overline{)50000} \end{array} = 45 \text{ CFH}$$

2. Total distance of gas line = 125′ (Figure 2 in assignment sheet)

   From column for 125′ (Table 2), 45 CFH is larger than 44, so the next larger size is used.

3. Pipe size for barbecue is $^3/_4$″

Fuel Piping Systems
Unit 4-E

Written Test

Name ______________________ Date __________ Score __________

1. Match the terms on the right with the correct definitions.

_______ a. Gas as it comes from the earth, refined and piped directly to the consumer

_______ b. Gas usually made from petroleum and natural gas combinations

_______ c. Liquefied petroleum gas; a petroleum product

_______ d. Gas which has a low reaction to high pressures, high temperatures, flames, or sparks

_______ e. An assembly of semi-rigid or flexible tubing and fittings to carry fuel between a fuel piping outlet and a fuel burning appliance

_______ f. American Society for Testing and Materials

_______ g. Local government board which administers gas code enforcement

_______ h. Metals having iron as their base such as steel and cast iron

_______ i. Metals containing no iron such as copper, brass, and aluminum

_______ j. British thermal unit; the amount of heat needed to raise one cubic foot of water one degree Fahrenheit

_______ k. Cubic feet per hour

_______ l. American Gas Association

1. Nonferrous
2. Appliance fuel connector
3. Administrative authority
4. ASTM
5. Manufactured gas
6. Natural gas
7. LPG
8. Ferrous
9. Inert gas
10. AGA
11. BTU
12. CFH

2. Select materials for pipe, fittings, and valves which are commonly used in fuel piping systems by placing an "X" next to those materials that may be used for pipe, an "O" next to those that may be used for fittings and valves, an "XO" next to those that may be used for all, and "No" next to those that may not be used for any.

_______ a. Cast iron

_______ b. Wrought steel

_______ c. Vitreous clay

Written Test

________ d. Copper tubing

________ e. Plastic

________ f. Brass

________ g. Galvanized steel

3. Distinguish among methods of joining fuel piping for different types of materials by placing a "B" next to methods used for black steel, a "C" next to methods used for copper, and a "P" next to methods used for plastic.

________ a. Flanged

________ b. Heat fusion (welded)

________ c. Flared

________ d. Threaded

________ e. Solvent welded

________ f. Welded

________ g. Compression

4. Select true statements concerning basic principles of natural gas codes by placing an "X" next to the true statements.

________ a. All joints in the piping system, unless welded, shall be screwed joints, having approved standard threads.

________ b. Zinc coatings (galvanizing) are considered adequate protection for piping below ground.

________ c. Gas piping supplying more than one building on any one premise shall be equipped with separate shutoff valves to each building, so arranged that the gas supply can be turned on or off to any individual or separate building.

________ d. Bushings may be used in concealed locations.

________ e. Gas piping may be installed in or on the ground under any building.

________ f. Where water vapor is present in the fuel gas served, pipes may be wrapped to help disburse water.

________ g. Ferrous gas piping installed underground in exterior locations shall be protected from corrosion by approved coatings or wrapping material, and all such horizontal piping shall have at least 12" of earth cover or other equivalent protection.

________ h. All gas pipe protective coatings shall be approved types, machine applied, and conform to recognized standards.

________ i. Material used for backfill around the pipe shall be free of rocks, building materials, ashes, and trash.

________ j. Appliance connections shall at no time have a diameter less than that of the inlet connection to the appliance as provided by the manufacturer.

5. Complete the following statements concerning fuel piping testing methods by circling the correct words.

   a. When applying pressure to test the fuel piping, **(inert gas, pure oxygen)** should be used.

   b. Gas piping should withstand a pressure of at least **(6, 10)** inches of mercury measured with a manometer for a period of not less than **(10, 60)** minutes without showing a drop in pressure.

   c. Leaks can be located by applying **(grease, soap and water)** to the piping joints.

   d. **(Alkalines, Acids)** should not be used to locate leaks.

   e. Water **(should, should not)** be introduced into the piping system to check for leaks.

Permission to duplicate this test is granted.

Fuel Piping Systems
Unit 4-E

Answers to Written Test

1. a. 6
   b. 5
   c. 7
   d. 9
   e. 2
   f. 4
   g. 3
   h. 8
   i. 1
   j. 11
   k. 12
   l. 10

2. a. No
   b. XO
   c. No
   d. X
   e. XO
   f. O
   g. No

3. a. B, P
   b. P
   c. C
   d. B
   e. P
   f. B
   g. P

4. a, c, g, h, i, j

5. a. Inert gas
   b. 6, 10
   c. Soap and water
   d. Acids
   e. Should not

Fuel Piping Systems
Unit 4-E

Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Assignment Sheet Rating

Assignment Sheet 1—Size a Gas Pipe for Residential Construction Rating ______

Comments: ____

____

Job Sheet Rating

Job Sheet 1—Perform Leak Tests on Gas Supply Lines Rating ______

Comments: ____

____

Written Test Scores

Pretest ________ Posttest ________ Other ________

Other ____

____

Teacher Signature ______________________ Date __________

Student Signature ______________________ Date __________

Permission to duplicate this form is granted.

Water Valves and Faucets
Unit 1-F

Unit Contents

Teacher Components **Page**

Suggested Activities 3
Written Test 7
Answers to Written Test 13
Unit Evaluation Form 15

Student Components **Page**

Objective Sheet F-1
Information Sheet F-3
Job Sheets
  1—Install a Stop and Waste Valve (Solder Method) F-11
  2—Install a Kitchen Sink Faucet F-13
  3—Install a Dual Control Lavatory Faucet With Pop-Up Drain Plug F-21
  4—Disassemble and Reassemble a Single Lever Kitchen Sink Faucet F-25

Water Valves and Faucets
Unit 1-F

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resources Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Review "Instructions for Evaluating Student Performance."
- Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

Unit Introduction

- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and materials are available. Review criteria for evaluation of this activity.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Have the students look through plumbing catalogs for different types of faucets. Have them select four faucet styles and find their prices. **(Reading; decision making; reasoning; and material selection)**
- Explain and discuss the function of each water valve and the location of each water control valve in a typical residential application. **(Listening; reasoning; decision making; and material selection)**
- Disassemble several basic types of valves for the students to study. **(Knowing how to learn; and reasoning)**
- Tour the school facilities, showing the students specific applications of various types of valves. **(Listening; decision making; reasoning; and selection)**
- Provide examples of different types of faucets for the students to examine. **(Knowing how to learn; and reasoning)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.
- Make copies of the written test. Add or modify test items as needed.
- Give and evaluate written test.
- Compile the job sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignments or supplemental activities that should be part of the unit evaluation.
- Meet individually with students to evaluate their progress through this unit of instruction and indicate to them possible areas of improvement.
- Reteach and retest as required.

Suggested Activities

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
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Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

Resources Used in Developing This Unit

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- Blankenbaker, Keith E. *Modern Plumbing*. South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.
- *Delta Faucet Catalog*. Indianapolis: Delta Faucet Company.

Suggested Supplemental Resources

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- Massey, Howard C. *Plumber's Handbook*. 5th ed. Carlsbad, CA: Craftsman Book Company, 1994.

Water Valves and Faucets
Unit 1-F

Written Test

Name ______________________ Date __________ Score __________

1. Match the terms on the right with their definitions.

_______ a. Mechanical device that regulates the flow of liquid in a pipe

_______ b. Fixture used for drawing liquid from a pipe

_______ c. Valve that has a drain plug on the discharge side and is used as a cut-off valve

_______ d. The distance between valve shanks on a sink faucet or a lavatory faucet

_______ e. Bath and shower faucet used to change flow from tub filler to shower head or in the reverse direction

_______ f. Decorative metal shield over valve body of faucets

1. Faucet
2. Diverter
3. Escutcheon
4. Spread
5. Valve
6. Stop and waste valve

2. List five types of valves.

a. ______________________________

b. ______________________________

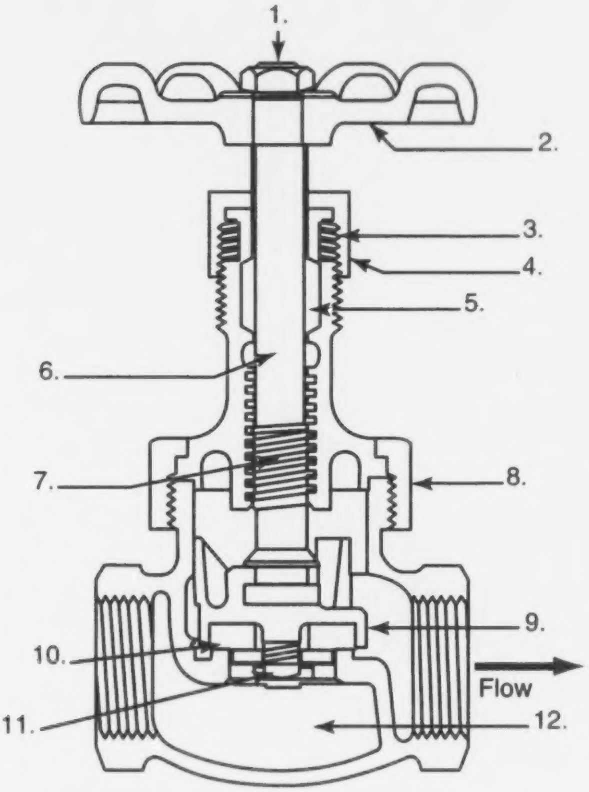
c. ______________________________

d. ______________________________

e. ______________________________

Written Test

3. Match the parts of a globe valve with their locations.



Courtesy of Stockham

______ a. Wheel

______ b. Body

______ c. Screw (rising stem)

______ d. Disc retaining nut

______ e. Packing gland

______ f. Wheel nut

______ g. Stem

______ h. Union bonnet

______ i. Packing

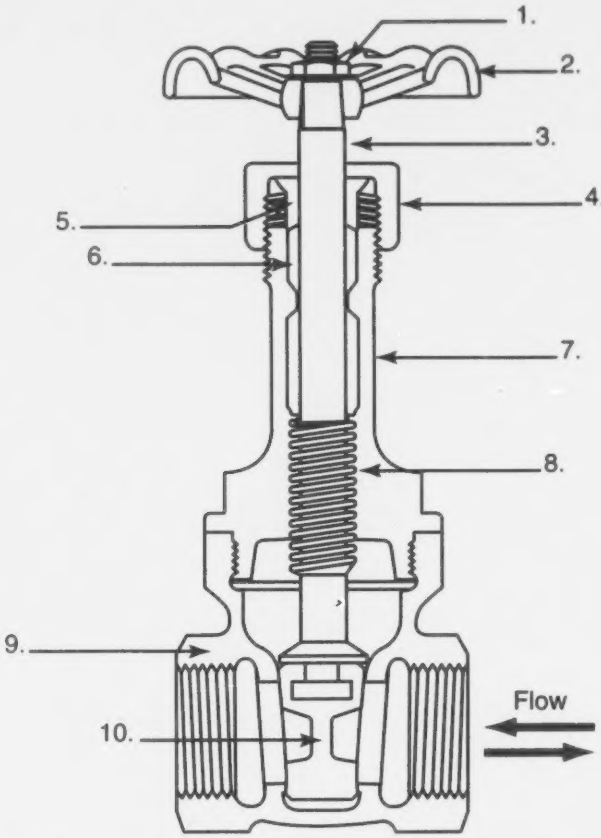
______ j. Composition disc

______ k. Disc holder

______ l. Packing nut

Written Test

4. Match the parts of a gate valve with their locations.



Courtesy of Stockham

_____ a. Stem

_____ b. Disc

_____ c. Wheel nut

_____ d. Body

_____ e. Packing gland

_____ f. Screw (rising stem)

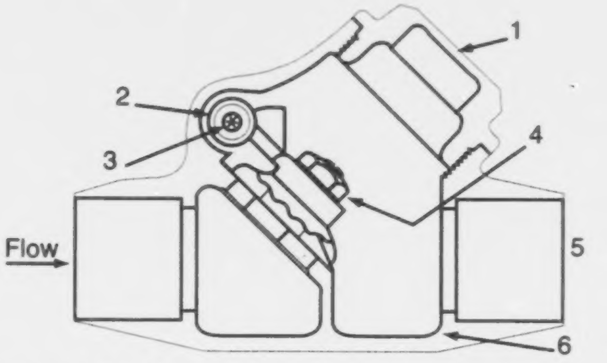
_____ g. Packing

_____ h. Packing nut

_____ i. Wheel

_____ j. Bonnet

5. Match the parts of a check valve with their locations.



Courtesy of Stockham

______ a. Hinge pin

______ b. Body

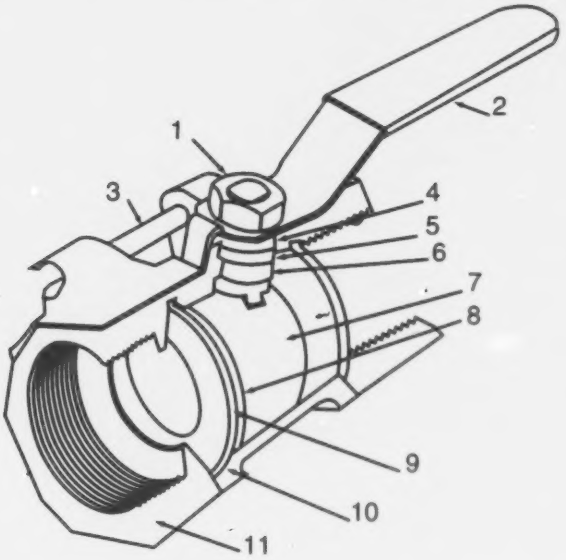
______ c. Cap

______ d. Hinge

______ e. Disc

______ f. Disc hinge nut

6. Match the parts of a ball valve with their locations.



______ a. Handle nut

______ b. Body seal

______ c. Body bolt

______ d. Follower

______ e. Ball

______ f. Body end

______ g. Handle

______ h. Seat

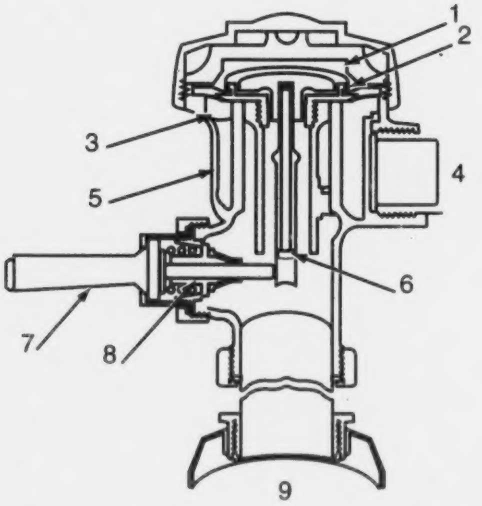
______ i. Packing

______ j. Stem

______ k. Body

Written Test

7. Match the parts of a flush valve with their locations.



Courtesy of Sloan Valve Co.

______ a. Outlet to fixture

______ b. Handle

______ c. Diaphragm

______ d. Bypass

______ e. Upper chamber

______ f. Auxiliary valve

______ g. Plunger

______ h. Lower chamber

______ i. Inlet from water supply line

8. Distinguish between single and dual control faucets by placing an "S" in the blanks next to the characteristics of a single control faucet.

______ a. Consists of either two compression or noncompression valves

______ b. Consists of either a rotating ball valve or rotating cylinder valve

Written Test

9. Select four features that best describe each of the types of faucets by placing the correct features in the appropriate blanks. Features may be used more than once.

a. Kitchen sink faucet

- ____________
- ____________
- ____________
- ____________

b. Lavatory faucet

- ____________
- ____________
- ____________
- ____________

c. Bath and shower faucet

- ____________
- ____________
- ____________
- ____________

d. Shower faucet

- ____________
- ____________
- ____________
- ____________

1. Single and dual control valves
2. Shower head
3. Usually 4″ centers (dual control)
4. Usually 8″ centers (dual control)
5. Aerator
6. Spray
7. Main body of valve and water piping installed during rough-in
8. Usually supplied with pop-up drain fitting
9. Stationary spout
10. Hot and cold water valves
11. Swing spout (deck or wall mount)
12. Diverter

Permission to duplicate this test is granted.

Water Valves and Faucets
Unit 1-F

Answers to Written Test

1.
    a. 5
    b. 1
    c. 6
    d. 4
    e. 2
    f. 3

2.
    a. Globe valve
    b. Gate valve
    c. Check valve
    d. Ball valve
    e. Flush valve

3.
    a. 2
    b. 12
    c. 7
    d. 11
    e. 3
    f. 1
    g. 6
    h. 8
    i. 5
    j. 10
    k. 9
    l. 4

4.
    a. 3
    b. 10
    c. 1
    d. 9
    e. 5
    f. 8
    g. 6
    h. 4
    i. 2
    j. 7

5.
    a. 3
    b. 6
    c. 1
    d. 2
    e. 5
    f. 4

6.
    a. 1
    b. 9
    c. 3
    d. 4
    e. 7
    f. 11
    g. 2
    h. 8
    i. 5
    j. 6
    k. 10

7.
    a. 9
    b. 7
    c. 3
    d. 2
    e. 1
    f. 6
    g. 8
    h. 5
    i. 4

8. b

9. Answers should include any four of the following features for each type of faucet.
    a. Kitchen sink faucet—1, 4, 5, 6, 10, 11
    b. Lavatory faucet—1, 3, 8, 9, 10
    c. Bath and shower faucet—1, 2, 4, 7, 9, 10, 12
    d. Shower faucet—1, 2, 4, 7, 10

Water Valves and Faucets
Unit 1-F

Unit Evaluation Form

Student Name ______________________________ Unit Rating ____________

Job Sheet Ratings

Job Sheet 1—Install a Stop and Waste Valve (Solder Method) Rating ________

Comments: ____

____

Job Sheet 2—Install a Kitchen Sink Faucet Rating ________

Comments: ____

____

Job Sheet 3—Install a Dual Control Lavatory Faucet
With Pop-Up Drain Plug Rating ________

Comments: ____

____

Job Sheet 4—Disassemble and Reassemble
a Single Lever Kitchen Sink Faucet Rating ________

Comments: ____

____

Written Test Scores

Pretest ________ Posttest ________ Other ________

Other ____

____

Teacher Signature ______________________________ Date ______________

Student Signature ______________________________ Date ______________

Permission to duplicate this form is granted.

Drainage Connections
Unit 2-F

Unit Contents

Teacher Components **Page**

Suggested Activities 3
Written Test 7
Answers to Written Test 9
Unit Evaluation Form 11

Student Components **Page**

Objective Sheet F-31
Information Sheet F-33

Job Sheets

1—Install a Cast Iron Water Closet Flange F-37
2—Install a Plastic Water Closet Flange F-41
3—Install a Brass to Copper Pipe Water Closet Flange F-43
4—Install a Brass to Lead Pipe Water Closet Flange F-45
5—Install a Lavatory Trap F-49
6—Install a Kitchen Sink Trap F-53

Drainage Connections
Unit 2-F

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resources Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Review "Instructions for Evaluating Student Performance."
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Delivery and Application

Unit Introduction

- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and materials are available. Review criteria for evaluation of this activity.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Show students different types of drainage connections. **(Listening; and material selection)**
- Explain why traps must have seals. **(Listening; and reasoning)**
- Review safety precautions when caulking and soldering. **(Listening; and application)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.
- Make copies of the written test. Add or modify test items as needed.
- Give and evaluate written test.
- Compile the job sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignments or supplemental activities that should be part of the unit evaluation.
- Meet individually with students to evaluate their progress through this unit of instruction and indicate to them possible areas of improvement.
- Reteach and retest as required.

Suggested Activities

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

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Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

Resources Used in Developing This Unit

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- Massey, Howard C. *Plumber's Handbook*. 5th ed. Carlsbad, CA: Craftsman Book Company, 1994.

Drainage Connections
Unit 2-F

Written Test

Name ______________________________ Date ______________ Score ______________

1. Match the terms on the right with their definitions.

______ a. Movement of liquid upward through cellular structure of fibrous strands or through structure of other solids

______ b. Rubber seal used around stems of some valves to prevent water from leaking out

______ c. A soft prepared mixture used to seal sink rims, drain outlets, and other places where a sealant is needed

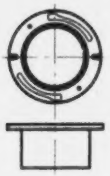
______ d. A recessed strainer fitting into the drain outlet of a sink

______ e. Depth of water held in a trap under normal operating conditions

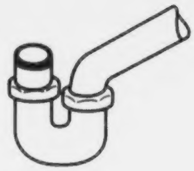
______ f. Loss of water (especially in a drainage trap) to the atmosphere

1. Plumber's putty
2. Evaporation
3. Basket strainer
4. Seal of a trap
5. Capillary attraction
6. O-ring

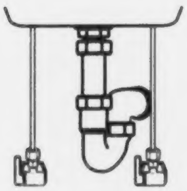
2. Identify the following types of drainage connections used in residential plumbing.



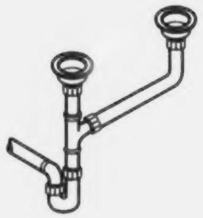
a. ______________________________



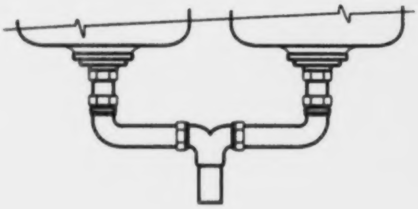
b. ______________________________

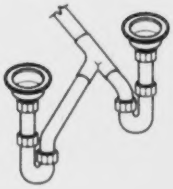


c. ______________________________



d. ______________________________





e. ______________________ f. ______________________

3. List four ways a trap can lose its seal.

   a. ______________________

   b. ______________________

   c. ______________________

   d. ______________________

Permission to duplicate this test is granted.

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Drainage Connections
Unit 2-F

Answers to Written Test

1.
    a. 5
    b. 6
    c. 1
    d. 3
    e. 4
    f. 2

2.
    a. Water closet flange (cast iron shown)
    b. Lavatory P trap
    c. Single sink/vanity
    d. Double well continuous waste—end outlet
    e. Double well continuous waste—center outlet
    f. Single waste—2 traps

3. Any four of the following:
    - Evaporation
    - Capillary attraction
    - Siphonage
    - Leak
    - Back pressure

Drainage Connections
Unit 2-F

Unit Evaluation Form

Student Name ______________________________ Unit Rating ____________

Job Sheet Ratings

Job Sheet 1—Install a Cast Iron Water Closet Flange Rating ______

Comments: ______________________________

____

Job Sheet 2—Install a Plastic Water Closet Flange Rating ______

Comments: ______________________________

____

Job Sheet 3—Install a Brass to Copper Pipe Water Closet Flange Rating ______

Comments: ______________________________

____

Job Sheet 4—Install a Brass to Lead Pipe Water Closet Flange Rating ______

Comments: ______________________________

____

Job Sheet 5—Install a Lavatory Trap Rating ______

Comments: ______________________________

____

Job Sheet 6—Install a Kitchen Sink Trap Rating ______

Comments: ______________________________

____

Unit Evaluation Form

Written Test Scores

Pretest ____________ Posttest ____________ Other ____________

Other ____

____

Teacher Signature ______________________________ Date ____________________

Student Signature ______________________________ Date ____________________

Permission to duplicate this form is granted.

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Fixtures and Appliances
Unit 3-F

Unit Contents

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Answers to Written Test 15
Unit Evaluation Form 17
Transparency Masters
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  2—Gas Water Heater 21
  3—Electric Water Heater 23

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Information Sheet F-59
Job Sheets
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  2—Install a Wall-Mounted Lavatory F-77
  3—Install a Recessed Bathtub F-81
  4—Install Shower Bath Accessories in a Ceramic Tile Bathroom F-85
  5—Install an Electric Water Heater F-87
  6—Install a Dishwasher F-89
  7—Install a Garbage Disposal Unit F-91
  8—Install a Gas Water Heater F-93

Fixtures and Appliances
Unit 3-F

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resources Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Make transparencies from the transparency masters included in this unit.
- Review "Instructions for Evaluating Student Performance."
- Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

Unit Introduction

- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and materials are available. Review criteria for evaluation of this activity.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Provide manufacturer's specifications and installation procedures for various fixtures and appliances the students will be working on. **(Reading; information acquisition and evaluation; and application)**

- Have students compare older water closet (toilet) tank assemblies with newer models. Show TM 1—How a Toilet Works, and discuss how the tank components may vary from model to model. **(Listening; reasoning; and information acquistion)**

- Conduct a field trip to a residential construction site while various fixtures and appliances are being installed. Coordinate this with the plumbing contractor. **(Listening; and application)**

- Provide local plumbing code books for students to check local installation requirements for fixtures and appliances. Have them note any differences from those listed in Objective 3 of the information sheet. **(Reading; reasoning; information acquisition and evaluation; and interpretation)**

- Discuss the costs of various fixtures and appliances and stress the importance of being careful not to damage these appliances. **(Listening; speaking; responsibility; money; and customer service)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.

- Make copies of the written test. Add or modify test items as needed.

- Give and evaluate written test.

- Compile the job sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignments or supplemental activities that should be part of the unit evaluation.

- Meet individually with students to evaluate their progress through this unit of instruction and indicate to them possible areas of improvement.

- Reteach and retest as required.

Suggested Activities

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

Product evaluation—Once the student has satisfactorily completed the procedure, rate the student product (outcome) using the criteria which have been provided as part of the job sheet. If the student's product is unacceptable, have the student review the materials and submit another product for evaluation.

Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

Resources Used in Developing This Unit

- Barclay, Leney. *Residential Plumbing*. Revised by Hank Johnson. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1985.
- Blankenbaker, Keith E. *Modern Plumbing*. South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.

Suggested Supplemental Resources

- Massey, Howard C. *Plumber's Exam*. 5th ed. Carlsbad, CA: Craftsman Book Company, 1996.
- Massey, Howard C. *Plumber's Handbook*. 5th ed. Carlsbad, CA: Craftsman Book Company, 1994.

Fixtures and Appliances
Unit 3-F

Written Test

Name ______________________ Date ____________ Score ____________

1. Match the terms on the right with their definitions. Terms and definitions are continued on the next page.

_______ a. A receptacle for wastes that are ultimately discharged into the drainage system

_______ b. A special class of plumbing fixture intended to perform a special function

_______ c. Wood or other support placed in the building walls to which plumbing fixtures can be attached

_______ d. Water receptacle shaped to accommodate the entire body for bathing

_______ e. A low set bowl equipped with hot and cold running water that is used especially for bathing the internal and external genitals and posterior parts of the body

_______ f. An electric appliance for washing dishes

_______ g. A common measure of the probable discharge into the drainage system by various types of plumbing fixtures on the basis of one unit being equal to 7.5 gallons per minute of discharge

_______ h. The drain line from the trap of a fixture to the junction of that drain with any other pipe

_______ i. A water supply pipe between the fixture supply pipe and a water distribution pipe

_______ j. A water supply pipe connecting the fixture with the fixture branch pipe

_______ k. The top edge of a plumbing fixture or receptacle from which the water overflows

_______ l. To wash out with a large amount of water

_______ m. An electric grinding device used with water to grind food wastes and discharge them into the drainage system

_______ n. A bathroom containing a water closet and lavatory

1. Half-bath
2. Fixture drain
3. Bathtub
4. Three-quarter bath
5. Vanity
6. Plumbing fixture
7. Fixture branch
8. Flush
9. Bidet
10. Wall-hung
11. Kitchen sink
12. Dishwasher
13. Plumbing appliance
14. Fixture supply
15. Lavatory
16. Backing
17. Garbage disposal
18. Water closet (toilet)
19. Drainage fixture unit (DFU)

_______ o. A shallow flat-bottom fixture used in the kitchen for cleaning dishes and in the preparation of certain foods

_______ p. A fixed tub installed in a laundry room of a home; supplied with cold and hot water and a drain connection and used for washing clothes and other household items

_______ q. A fixture designed for washing the hands and face; commonly found in bathrooms and rest rooms

_______ r. A bathroom containing a water closet, lavatory, and a shower bath

_______ s. A water-flushed plumbing fixture designed to receive human excrement directly from the user of the fixture

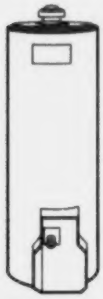
_______ t. Refers to a plumbing fixture that is supported from a wall

_______ u. A bathroom fixture consisting of a lavatory set into or onto the top of a cupboard or cabinet

_______ v. A bathroom containing a water closet, lavatory, and bathtub

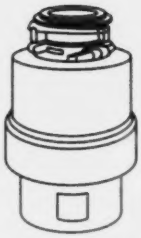
20. Laundry tray
21. Flood level rim
22. Full bath

2. Identify common fixtures and appliances used in residential plumbing.



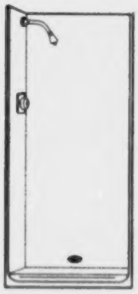
Courtesy of A.O. Smith

a. ________________________________

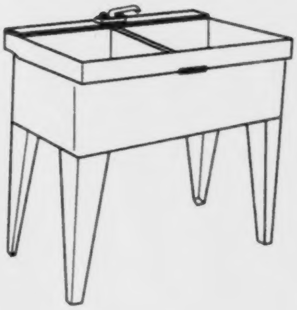


b. ________________________________

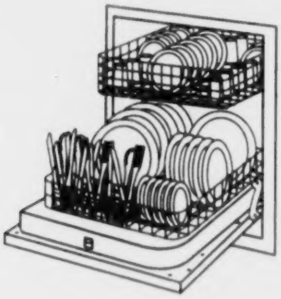
Written Test



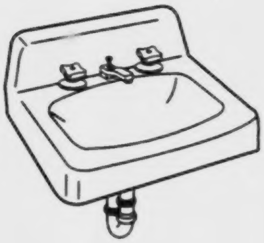
c. ______________________________



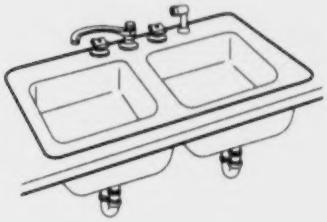
d. ______________________________



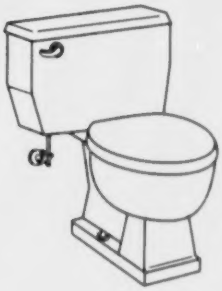
e. ______________________________



f. ______________________________

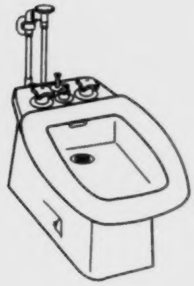


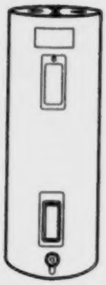
g. ______________________________



h. ______________________________

Written Test

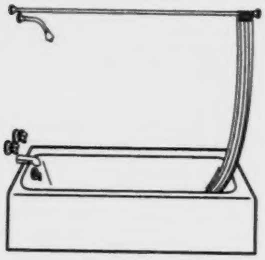


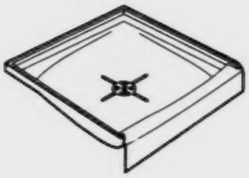


Courtesy of A.O. Smith

i. ______________________________

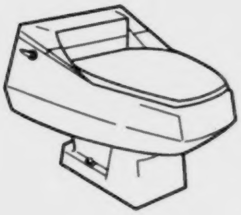
j. ______________________________

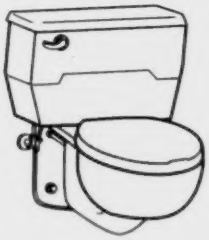




k. ______________________________

l. ______________________________

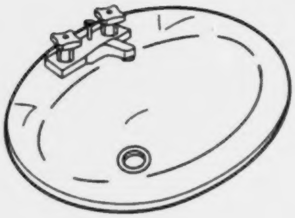




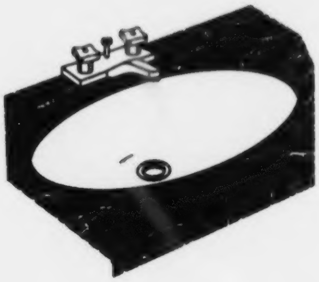
m. ______________________________

n. ______________________________

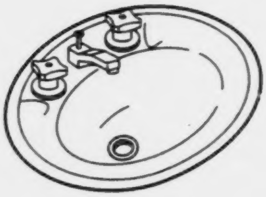
Written Test



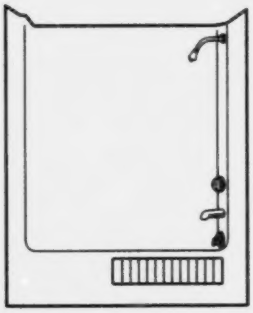
o. ______________________________



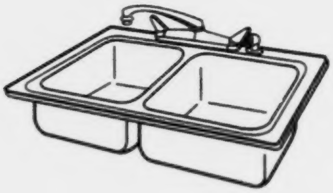
p. ______________________________



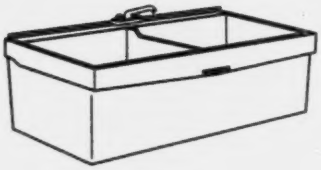
q. ______________________________



r. ______________________________



s. ______________________________



t. ______________________________

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Written Test

3. Match fixtures and appliances on the right with their installation requirements.

_______ a. 1) Rated at 2 DFU
2) Requires a minimum of 1 1/2″ for drain pipe
3) Requires a minimum of 1 1/4″ for vent pipe
4) Requires a trap connection to the waste pipe
5) Requires a water fitting to deliver water to the nozzle
6) Has vacuum breaker on water supply

_______ b. 1) Rated at 2 DFU
2) Requires a minimum of 1 1/2″ for drain pipe
3) Requires a minimum of 1 1/2″ for vent pipe
4) Requires a trap connection to the waste pipe
5) Requires a water fitting to deliver water to the sink

_______ c. 1) Rated at 2 DFU
2) Usually installed directly below kitchen sink in place of the basket strainer
3) Requires a trap connection to the waste pipe
4) Requires kitchen sink water supply to provide adequate flushing of the drain
5) Requires electrical connection

_______ d. 1) Most common fuels are gas and electricity
2) Usually constructed to heat and store water
3) Usually constructed so the controls operate automatically

_______ e. 1) Rated at 6 DFU
2) Requires a minimum of 3″ for drain pipe
3) Requires a minimum of 2″ for vent pipe
4) Has trap as an integral part of the fixture
5) Has a built-in flushing device

_______ f. 1) Rated at 1 DFU
2) Requires a minimum of 1 1/4″ for drain pipe
3) Requires a minimum of 1 1/4″ for vent pipe
4) Requires a trap connection to the waste pipe
5) Requires a water fitting to deliver water into the lavatory

_______ g. 1) Rated at 2 DFU
2) Requires a minimum of 2″ for drain pipe
3) Requires a minimum of 1 1/2″ for vent pipe
4) Requires a trap connection to the waste pipe
5) Requires a water fitting to deliver water to the shower bath

1. Water closet
2. Lavatory
3. Bathtub
4. Shower bath
5. Bidet
6. Kitchen sink
7. Water heater
8. Garbage disposal
9. Dishwasher
10. Laundry tray

_______ h.
1) Rated at 2 DFU
2) Requires a minimum of 1 1/2" for drain pipe
3) Requires a minimum of 1 1/2" for vent pipe
4) Requires a water fitting to deliver water into the tub
5) Requires a trap and overflow connection to the waste pipe

_______ i.
1) Rated at 2 DFU
2) Requires a minimum of 1 1/2" for drain pipe
3) Requires a minimum of 1 1/4" for vent pipe
4) Requires a water fitting to deliver water to the laundry tray
5) Requires a trap connection to the waste pipe

_______ j.
1) Rated at 2 DFU
2) Requires a minimum of 1 1/2" for drain pipe
3) Requires a minimum of 1 1/4" for vent pipe
4) Most use a built-in pump to discharge waste water
5) Most have built-in automatic water controllers
6) Requires a trap connection to the waste pipe or disposal

4. Select true statements concerning the construction and materials used in the manufacture of fixtures and appliances by placing an "X" next to the true statements.

_______ a. Water closets are generally made in two sections, bowl and tank.

_______ b. Water closet tanks are not equipped with separately installed flushing mechanisms.

_______ c. Water closets are glazed and fired in a kiln at high heat for up to three days to ensure strength and quality of finish.

_______ d. Lavatories can be made from vitreous china, enameled cast iron, plastic, and fiberglass.

_______ e. Bath bottoms should have a 1/2" per foot pitch toward the drain.

_______ f. Shower baths are usually made of vitreous china.

_______ g. Shower baths are available in sizes of 30" x 30", 36" x 36" , and 36" x 48".

_______ h. Bidets are installed directly on the floor, similar to a floor-mounted water closet.

_______ i. Kitchen sinks are only available in single wells.

_______ j. Most water heaters are steel tanks with bonded glass linings intended to prevent corrosion of the tank.

Written Test

_______ k. Water heaters are constructed with 4–5 pipe openings in the top.

_______ l. Black iron pipe and fittings should be used for the gas piping in gas water heaters.

_______ m. Water heaters are constructed with drain valves (boiler drains) at the bottom of the water tank.

_______ n. The electrical work for an electric water heater should be done by the plumber.

_______ o. Some electric water heaters have two heating elements.

_______ p. The four main components of a garbage disposal are the electric motor, grinding chamber, two grinding elements, and the sink fitting.

_______ q. Most disposals do not have a dishwasher drain connection.

_______ r. Dishwashers are available in self-contained units that need water and waste connections.

_______ s. Most laundry trays are made of terrazzo, cast iron, or wood.

_______ t. Double compartment and single compartment laundry trays are available.

Permission to duplicate this test is granted.

Fixtures and Appliances
Unit 3-F

Answers to Written Test

1.

a.	6	f.	12	k.	21	p.	20	u.	5
b.	13	g.	19	l.	8	q.	15	v.	22
c.	16	h.	2	m.	17	r.	4		
d.	3	i.	7	n.	1	s.	18		
e.	9	j.	14	o.	11	t.	10		

2.
a. Gas water heater
b. Garbage disposal
c. Shower enclosure
d. Floor model laundry tray
e. Dishwasher
f. Wall-hung lavatory
g. Self-rimming kitchen sink
h. Floor-set water closet with close coupled tank and bowl
i. Bidet
j. Electric water heater
k. Recessed bathtub
l. Shower base
m. One-piece floor-set tank and bowl combination water closet
n. Wall-hung siphon jet water closet with close-coupled tank and bowl
o. Self-rimming vanity lavatory
p. Under-counter vanity lavatory
q. Rim-type vanity lavatory
r. Bath-shower module
s. Rim-type kitchen sink
t. Wall-hung laundry tray

3.

a.	5	f.	2
b.	6	g.	4
c.	8	h.	3
d.	7	i.	10
e.	1	j.	9

4. a, c, d, g, h, j, l, m, o, p, r, t

Fixtures and Appliances
Unit 3-F

Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Job Sheet Ratings

Job Sheet 1—Install a Floor-Mounted Water Closet Rating ______

Comments: ______________________

Job Sheet 2—Install a Wall-Mounted Lavatory Rating ______

Comments: ______________________

Job Sheet 3—Install a Recessed Bathtub Rating ______

Comments: ______________________

Job Sheet 4—Install Shower Bath Accessories in a Ceramic Tile Bathroom Rating ______

Comments: ______________________

Job Sheet 5—Install an Electric Water Heater Rating ______

Comments: ______________________

Job Sheet 6—Install a Dishwasher Rating ______

Comments: ______________________

Job Sheet 7—Install a Garbage Disposal Unit Rating ______

Comments: ______________________

Unit Evaluation Form

Job Sheet 8—Install a Gas Water Heater Rating ________

Comments: ____

____

Written Test Scores

Pretest ________ Posttest ________ Other ________

Other ____

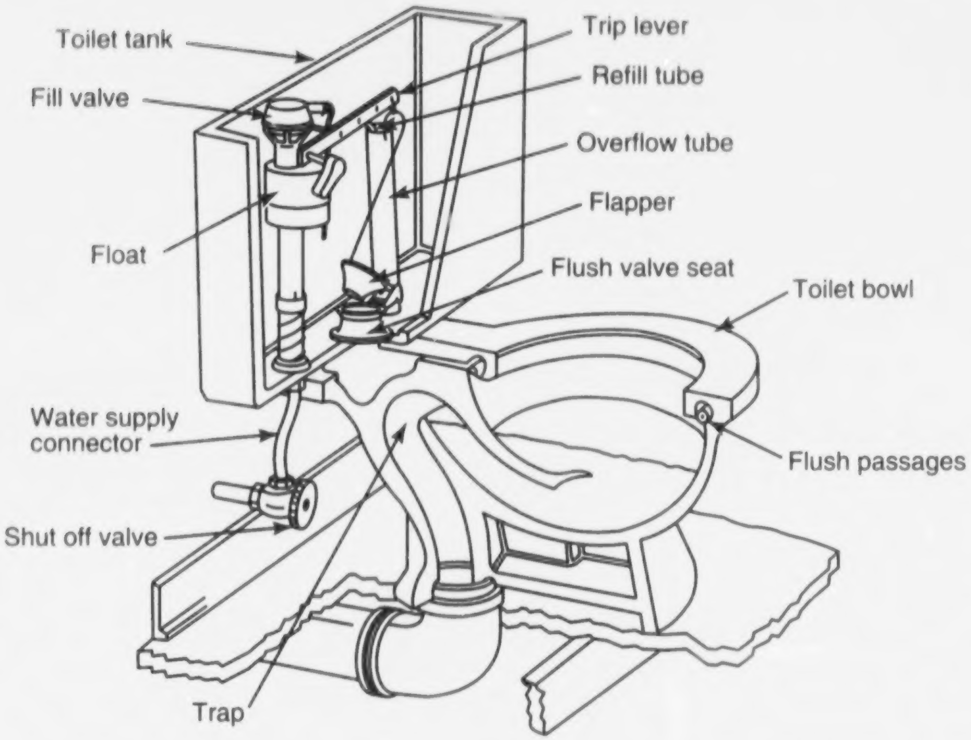
____

Teacher Signature ____________________ Date ____________

Student Signature ____________________ Date ____________

Permission to duplicate this form is granted.

How a Toilet Works



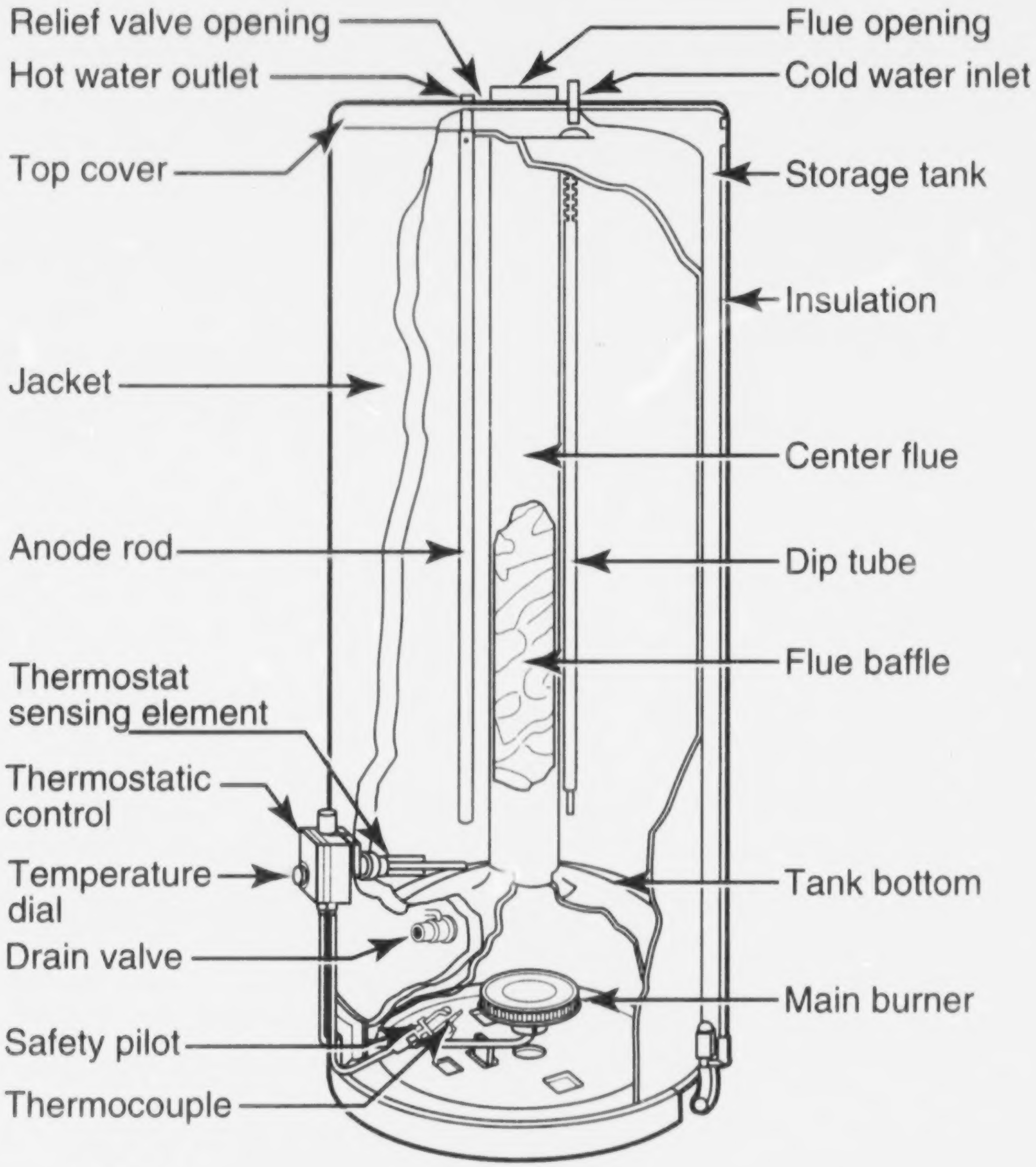
When the toilet is flushed, the trip lever raises the flapper/stopper chain (or wire), releasing tank water into the bowl via the flush passages. The water in the bowl yields to gravity and is siphoned out the trap.

Once the tank is empty, the flapper/stopper drops onto the flush valve seat and the valve float triggers an influx of water into the tank. As the water level rises, so does the float, until the preset refill level in the tank is reached.

Used with permission of Fluidmaster, Inc., 1998.

TM 1

Gas Water Heater



Courtesy of A.O. Smith

Sectional View of an Automatic Gas Storage Tank Water Heater

TM 2

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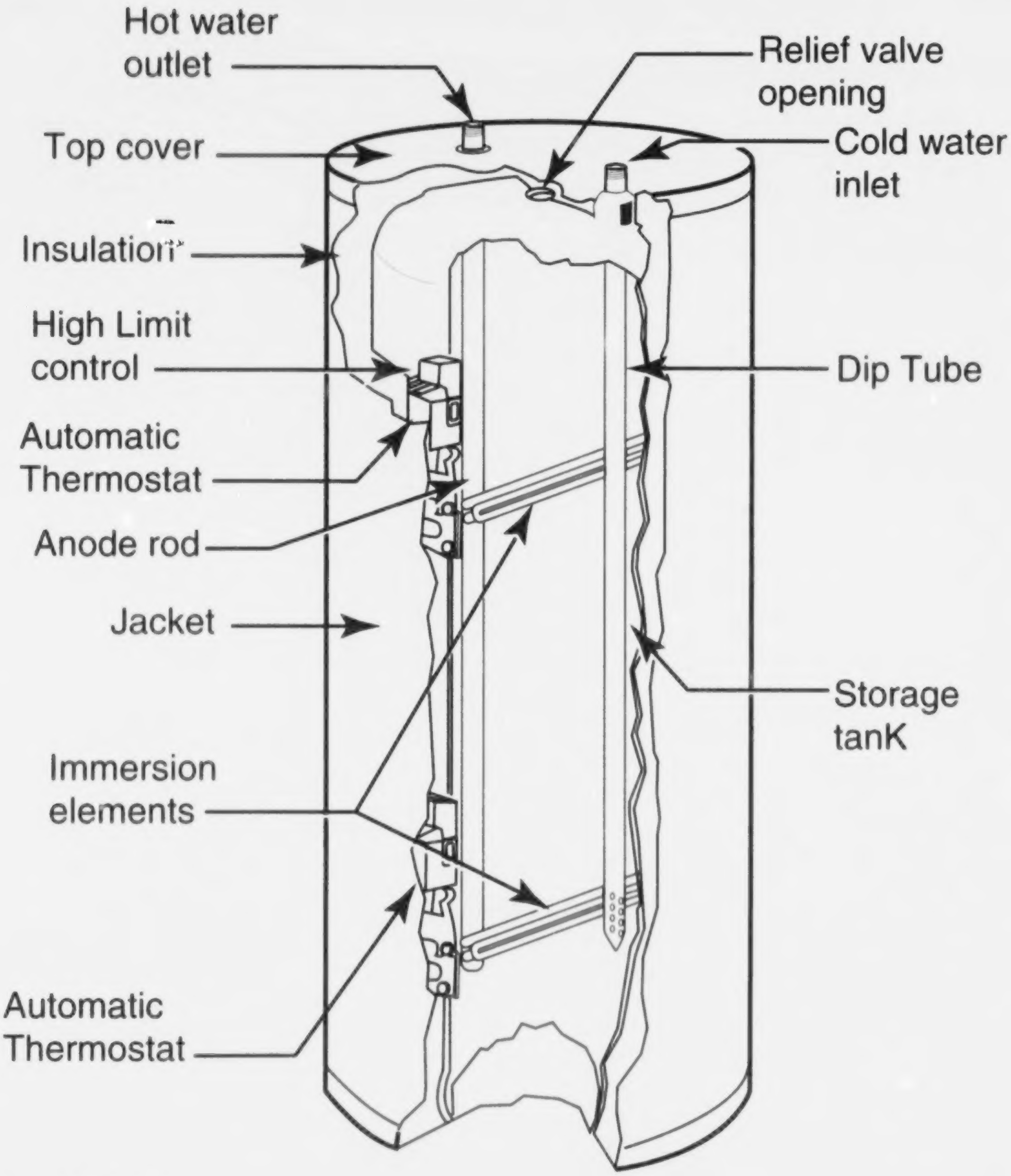
Electric Water Heater



Courtesy of A.O. Smith

Sectional View of an Automatic Electric Storage Tank Water Heater

Water Systems Maintenance and Repair
Unit 1-G

Unit Contents

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  2—Ball Cock 15
  3—Flush Valve 17
  4—Prefabricated Mechanical Hammer Arrestor 19

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Information Sheet G-3
Job Sheets
  1—Install a Prefabricated Air Chamber in a Water Supply Line G-9
  2—Replace a Section of Galvanized Water Supply Line G-11
  3—Thaw a Frozen Pipe With a Plumber's Torch G-13
  4—Repair a Leaking Faucet G-15
  5—Repair a Leaking Shower Valve G-17
  6—Replace a Gas Water Heater G-19
  7—Repair a Ball Cock on a Water Closet G-23
  8—Replace a Pressure Control Switch on a Water Pump G-25
  9—Insulate Water Lines G-27

Water Systems Maintenance and Repair
Unit 1-G

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resources Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Make transparencies from the transparency masters included in this unit.
- Review "Instructions for Evaluating Student Performance."
- Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

Unit Introduction

- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and materials are available. Review criteria for evaluation of this activity.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000.* These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Explain to the students the reasons for and advantages of installing an air chamber in piping. **(Listening; reasoning; and systems interrelationships)**
- Have the students visit a plumbing supply store. Find common repair parts that are readily available for faucets, valves, and water closets. Have the students note how the parts are sized or distinguished from one another and the advantages and disadvantages of different products that are designed to serve the same function. **(Listening; reasoning; and material selection)**
- Display the special tools needed to perform plumbing repairs. Discuss with the students which tools are the most helpful, which are designed the best, and which should be in a plumber's tool box. **(Listening; reasoning; and material selection)**
- Discuss the most common maintenance and repair procedures on water systems. **(Listening; and maintenance and troubleshooting)**
- Demonstrate the various methods of thawing frozen pipes and show different types of equipment commonly used. **(Listening; material selection; technology application; and maintenance and troubleshooting)**
- Discuss precautions that must be followed while thawing pipe to prevent personal injury and building damage. **(Listening; personal responsibility; and maintenance and troubleshooting)**
- Demonstrate the emergency repair procedures for fixing leaking pipes. **(Listening; and maintenance and troubleshooting)**
- Show different types of insulation that can be used for insulating pipes. **(Listening; material selection; and maintenance and troubleshooting)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.
- Make copies of the written test. Add or modify test items as needed.
- Give and evaluate written test.
- Compile the job sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignments or supplemental activities that should be part of the unit evaluation.
- Meet individually with students to evaluate their progress through this unit of instruction and indicate to them possible areas of improvement.
- Reteach and retest as required.

Suggested Activities

Instructions for Evaluating Student Performance

When the student is ready to perform a specific task, obtain a copy of the job sheet which may be found in either the teacher or student edition. Then observe the student performing the procedure.

Process evaluation—Place a mark in the box to the left of each designated checkpoint if the student has satisfactorily achieved the step(s) for each checkpoint area. If the student is unable to correctly complete the procedure, have the student review the materials and try again.

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Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

Option B

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

Resources Used in Developing This Unit

- Barclay, Leney. *Residential Plumbing*. Revised by Hank Johnson. Stillwater, OK: Mid-America Vocational Curriculum Consortium, 1985.
- Blankenbaker, Keith E. *Modern Plumbing*. South Holland, IL: The Goodheart-Willcox Company, Inc., 1992.

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- Massey, Howard C. *Plumber's Handbook*. 5th ed. Carlsbad, CA: Craftsman Book Company, 1994.

Water Systems Maintenance and Repair
Unit 1-G

Written Test

Name ______________________ Date __________ Score __________

1. Match the terms on the right with the correct definitions.

_____ a. Keeping equipment and plumbing systems functioning in an approved manner

_____ b. To remedy or restore something that is broken or not in proper working order

_____ c. Flame not confined to a protected area and therefore dangerous

_____ d. Water frozen in a pipe, causing stoppage and danger of pipe damage

_____ e. Failure to operate in a normal or usual manner

1. Frozen pipe
2. Repair
3. Malfunction
4. Maintenance
5. Open flame

2. Describe three methods of thawing frozen pipes.

a. ____

____

____

____

b. ____

____

____

____

c. ____

____

____

____

Written Test

3. Describe two emergency repair methods for leaking pipes.

   a. ____

   ____

   ____

   ____

   b. ____

   ____

   ____

   ____

4. Match water closet tank malfunctions on the right with their remedies.

_______ a. 1) Bend float arm to make sure float is clear of tank sides and is not held in a high position.
    2) Make sure float does not rise above desired water level by bending the float arm until desired level is reached.

_______ b. 1) Clean existing ball and wipe valve seat clean.
    2) If valve continues to leak, replace tank ball.

_______ c. 1) Make sure lift rods are straight and aligned over ball valve.
    2) Make sure trip lever is aligned over the ball valve.
    3) Make sure rod guide is aligned over ball valve.

_______ d. 1) Check linkage of float arm lever and valve plunger for defects which prevent valve closing.
    2) Replace valve washer.

_______ e. 1) Remove overflow tube and clean broken threads from tube base.
    2) Install new overflow tube.

1. Tank ball assembly fails to reseat ball valve due to misalignment.
2. Water continues to flow, draining through tank ball valve due to worn or deformed tank ball.
3. Water continues to flow, draining into base of overflow tube due to corrosion of threaded end of overflow tube.
4. Float rises too high in tank, allowing water to continue flowing and to drain into the overflow tube.
5. Leaking ball cock valve allows water to continue flowing after float rises to normal shut-off position.

Permission to duplicate this test is granted.

Water Systems Maintenance and Repair
Unit 1-G

Answers to Written Test

1.
   a. 4
   b. 2
   c. 5
   d. 1
   e. 3

2. Descriptions should include any three of the following methods:
   a. Open flame (low temperature flame)
      - Open faucet or valve affected by the freeze.
      - Apply heat at the lowest open end of the frozen section.
      - Slowly move the flame along the length of the frozen section of pipe; continue until water flows freely from pipe.

   b. Hot water
      - Open faucet or valve affected by the freeze.
      - Wrap the frozen section of pipe with clean cloths.
      - Pour hot water over the entire length of the frozen area, starting from the open end of the pipe, and continue until water flows freely from the pipe.

   c. Electric welding generator
      - Determine the location of the frozen section of pipe.
      - Select contact points as close as possible to the frozen area.
      - Be sure that contact points are free of rust, grease, or scale.
      - Remove meters, electrical ground connections, and couplings attached to plumbing in line to be thawed.
      - Set the direct-current generator to correct amperage for pipe to be thawed.
      - Connect pipe.
      - Apply current until water flows freely.

   d. Electric pipe thawer
      - Determine the location of the frozen section of the pipe.
      - Attach the pipe clamps at both ends of the frozen pipe section.
      - Plug unit into 110–120 volt house receptacle.
      - Turn on switch and adjust amperage flow to safe range as indicated.
      - Apply current until water flows freely.

   e. Flowing hot water
      - Remove fittings from pipe to be thawed.
      - Insert small pipe or tube into open end of frozen pipe.
      - Add an elbow and piece of vertical pipe to the outer end of the thaw pipe.
      - Place a bucket under the opening of the frozen pipe.
      - Insert a funnel in the open end of the vertical pipe.
      - Pour boiling water through the funnel and into the thaw pipe.
      - As the ice melts, push the thaw pipe farther into the frozen pipe.
      - Withdraw the thaw pipe quickly when the water starts to flow.

   f. Hair dryer
      - Open faucet or valve affected by the freeze.
      - Connect dryer to electrical power.
      - Apply heat over entire length of frozen area, starting from the open end of the pipe, and continue until water flows freely.

Answers to Written Test

3. Descriptions should include any two of the following applications:
   a. Rubber hose method
      - Turn off the water supply.
      - Cut the defective section of pipe at the leak.
      - Slip a small section of hose over one end of cut pipeline and line up pipes evenly.
      - Slide hose halfway over the other end of cut pipeline.
      - Fasten hose tightly with hose clamps.

   b. Sheet metal clamps method
      - Turn off the water supply.
      - Wrap the leaky area with sheet rubber.
      - Place sheet metal clamps, one on either side of the pipe, on the sheet rubber covering.
      - Fasten the clamps with bolts and nuts.

   c. C-clamp method
      - Turn off the water supply.
      - Cut a small piece of sheet rubber and place on the defective part of the pipe.
      - Place a small wooden block on the rubber sheet.
      - Place C-clamp in position and tighten against wooden block to hold sheet rubber on pipe.

4. a. 4
   b. 2
   c. 1
   d. 5
   e. 3

Water Systems Maintenance and Repair
Unit 1-G

Unit Evaluation Form

Student Name ________________________ Unit Rating ____________

Job Sheet Ratings

Job Sheet 1—Install a Prefabricated Air Chamber in a Water Supply Line Rating ________

Comments: ____

____

Job Sheet 2—Replace a Section of Galvanized Water Supply Line Rating ________

Comments: ____

____

Job Sheet 3—Thaw a Frozen Pipe With a Plumber's Torch Rating ________

Comments: ____

____

Job Sheet 4—Repair a Leaking Faucet Rating ________

Comments: ____

____

Job Sheet 5—Repair a Leaking Shower Valve Rating ________

Comments: ____

____

Job Sheet 6—Replace a Gas Water Heater Rating ________

Comments: ____

____

Job Sheet 7—Repair a Ball Cock on a Water Closet Rating ________

Comments: ____

____

Unit Evaluation Form

Job Sheet 8—Replace a Pressure Control Switch on a Water Pump Rating ________

Comments: ____

____

Job Sheet 9—Insulate Water Lines Rating ________

Comments: ____

____

Written Test Scores

Pretest ________ Posttest ________ Other ________

Other ____

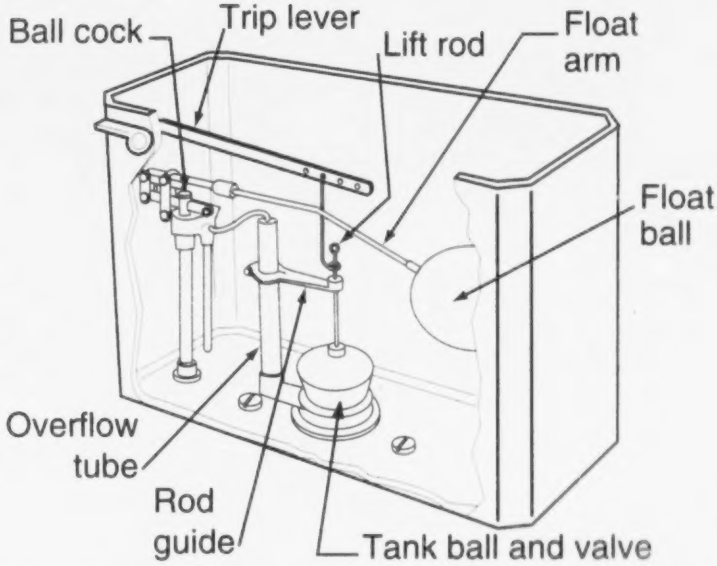
____

Teacher Signature ______________________ Date ____________

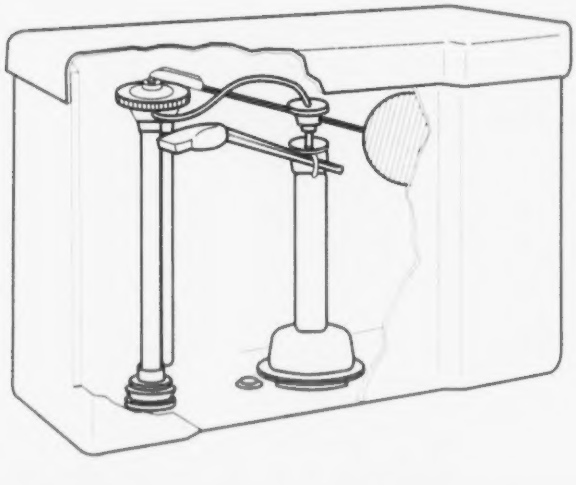
Student Signature ______________________ Date ____________

Permission to duplicate this form is granted.

Water Closet Tank



Principal Parts of a Water Closet Tank



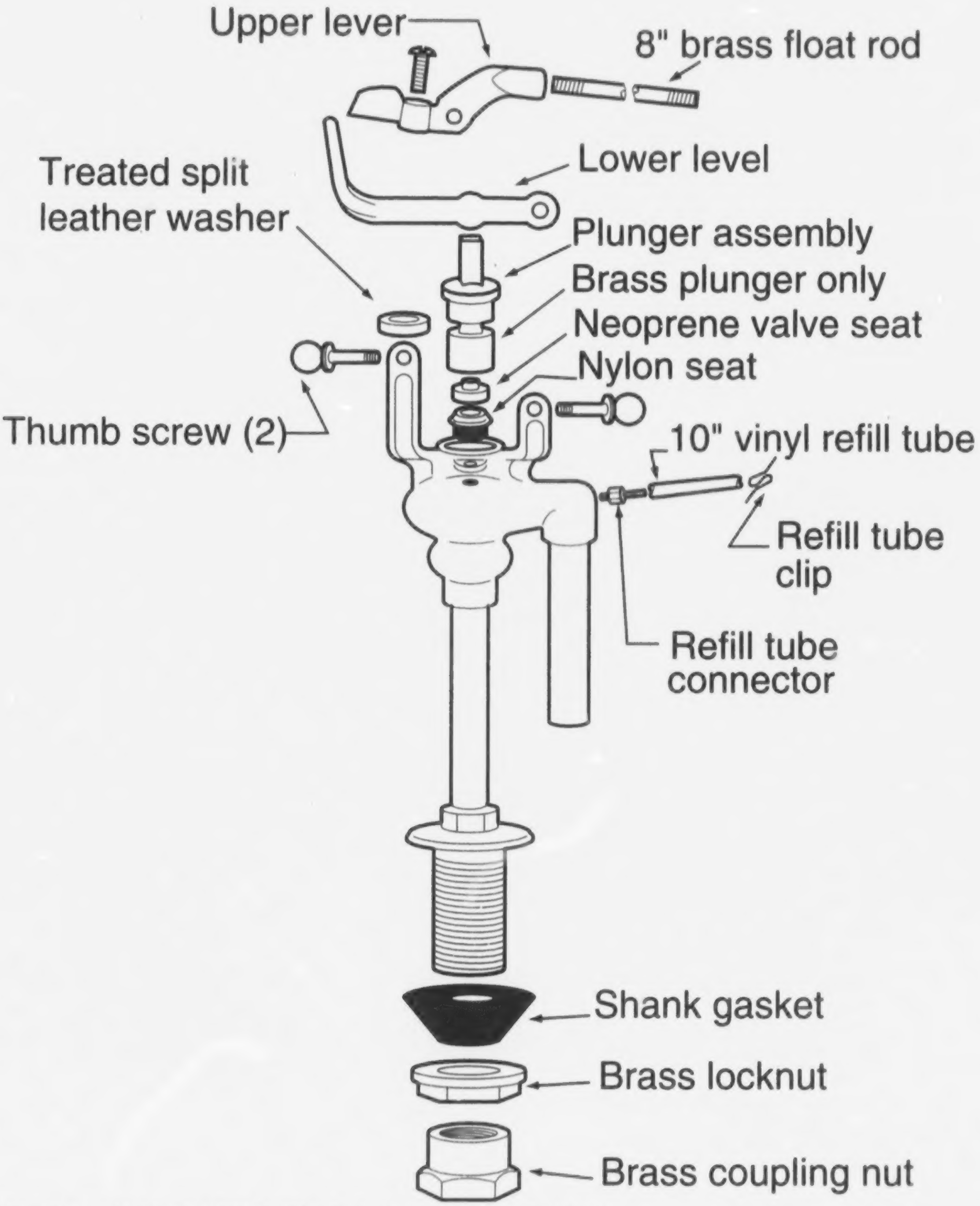
Plastic Tank and Controls

Information provided by Mansfield Plumbing Products, Inc.... America's Best Value!

436

TM 1

Ball Cock



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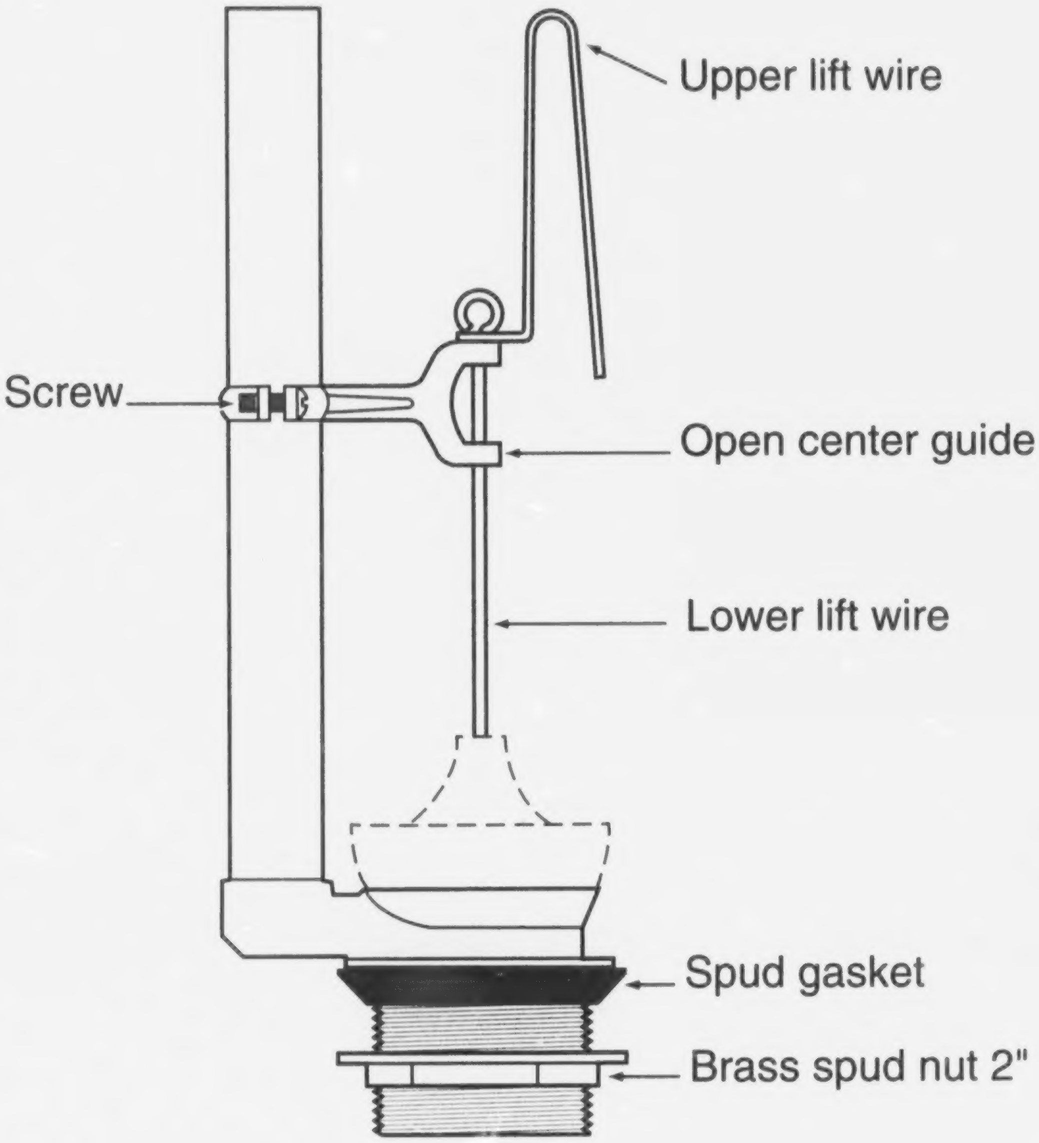
Flush Valve



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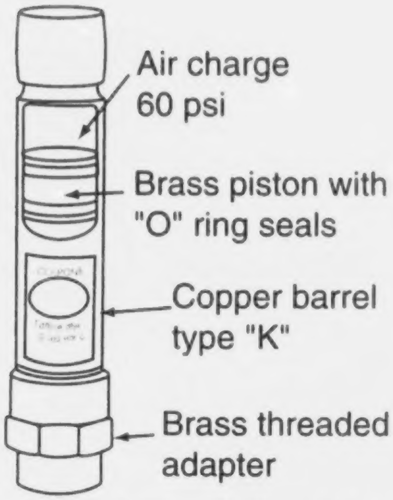
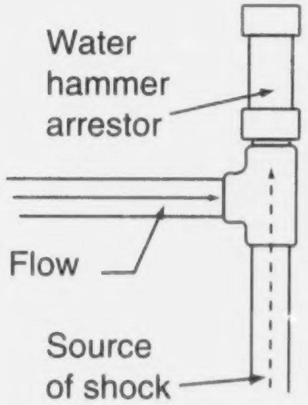
Prefabricated Mechanical Hammer Arrestor

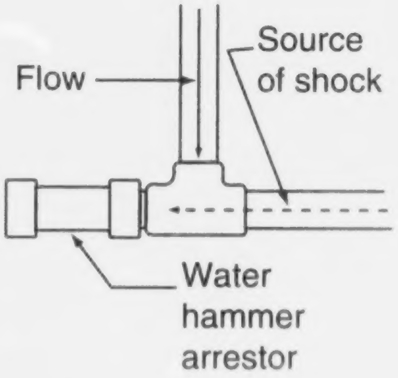


Sizes 1/2" - 8" diameter

Vertical Position



Horizontal Position



Note: Install near the last fixture in residence.

Courtesy of Precision Plumbing Products

Drainage Systems Maintenance and Repair
Unit 2-G

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Written Test 7
Answers to Written Test 9
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  4—Clear Obstructions From a Main Drain Line G-39

Drainage Systems Maintenance and Repair
Unit 2-G

Suggested Activities

Instructional Plan

Preparation

- Read the unit carefully and plan for instruction.
- Review "Teaching Suggestions." Plan for classroom activities.
- Plan your presentation to take advantage of student learning styles and to accommodate special-needs students.
- Prepare classroom. Put up posters and charts and display articles and other references related to this unit.
- Obtain films, videotapes, and other resources to supplement instruction of this unit. See "Resources Used in Developing This Unit" and "Suggested Supplemental Resources" for more information.
- Review "Instructions for Evaluating Student Performance."
- Make copies of the Unit Evaluation Form, one for each student.

Delivery and Application

Unit Introduction

- Provide students with unit of instruction.
- Discuss unit and specific objectives.
- Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
- Discuss and demonstrate the job sheets. Make sure all required tools, equipment, and materials are available. Review criteria for evaluation of this activity.

Suggested Activities

Teaching Suggestions

Note: Skill areas appearing in boldface type in the teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000*. These SCANS skills and competencies have been adapted by MAVCC to help instructors and program planners effectively articulate curriculum.

- Discuss the most common maintenance and repair procedures on drainage systems. **(Listening; and maintenance and troubleshooting)**
- Demonstrate the use of the different types of equipment used to clear stoppages in plumbing fixtures. **(Listening; material selection; and maintenance and troubleshooting)**
- Discuss the safety precautions that must be followed when using caustic chemicals to clear drains. **(Listening; and responsibility)**
- Discuss local plumbing code requirements concerning cleanout access points. **(Listening; responsibility; and acquisition and evaluation)**
- Describe to the students an orderly method of checking and testing a plumbing system to confirm an actual problem. **(Listening; and maintenance and troubleshooting)**

Evaluation

- Discuss the use of the Unit Evaluation Form with students. Explain the rating scale that will be used for student evaluation.
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Sample performance evaluation keys have been provided below. Many other keys are available. Select one rating (grading scale) which best fits your program needs.

Option A

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Drainage Systems Maintenance and Repair
Unit 2-G

Written Test

Name ______________________ Date __________ Score __________

1. Match the terms on the right with the correct definitions.

_______	a.	Chemicals in either liquid or powder form used to dissolve soap, grease, and other accumulations in drain pipe	1.	Plumber's friend
			2.	Snake
_______	b.	Rotary tool used by plumbers to clear drains	3.	Auger
_______	c.	Plunger used to help clear fixture drains, saving the plumber from messy work	4.	Caustic chemicals
_______	d.	Steel band or spring, coiled for easy use, used to clear plumbing drains		

2. List four types of equipment used to clear stoppages in plumbing fixtures.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

3. List three cleanout access points in a drainage system.

a. ______________________________

b. ______________________________

c. ______________________________

Permission to duplicate this test is granted.

Drainage Systems Maintenance and Repair
Unit 2-G

Answers to Written Test

1. a. 4
   b. 3
   c. 1
   d. 2

2. Any four of the following:
   - Plunger
   - Caustic chemicals
   - Plumber's snake
   - Trap and drain auger
   - Closet auger
   - Water ram

3. Any three of the following:
   - Cleanouts in sewer line
   - Base of stack
   - Traps
   - Vent terminals
   - Water closets

Drainage Systems Maintenance and Repair
Unit 2-G

Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Job Sheet Ratings

Job Sheet 1—Replace a Lavatory Trap Rating ______

Comments: ______________________________

____

Job Sheet 2—Clear Obstructions From a Lavatory Drain Rating ______

Comments: ______________________________

____

Job Sheet 3—Clear Obstructions From a Water Closet Drain Rating ______

Comments: ______________________________

____

Job Sheet 4—Clear Obstructions From a Main Drain Line Rating ______

Comments: ______________________________

____

Written Test Scores

Pretest ________ Posttest ________ Other ________

Other ______________________________

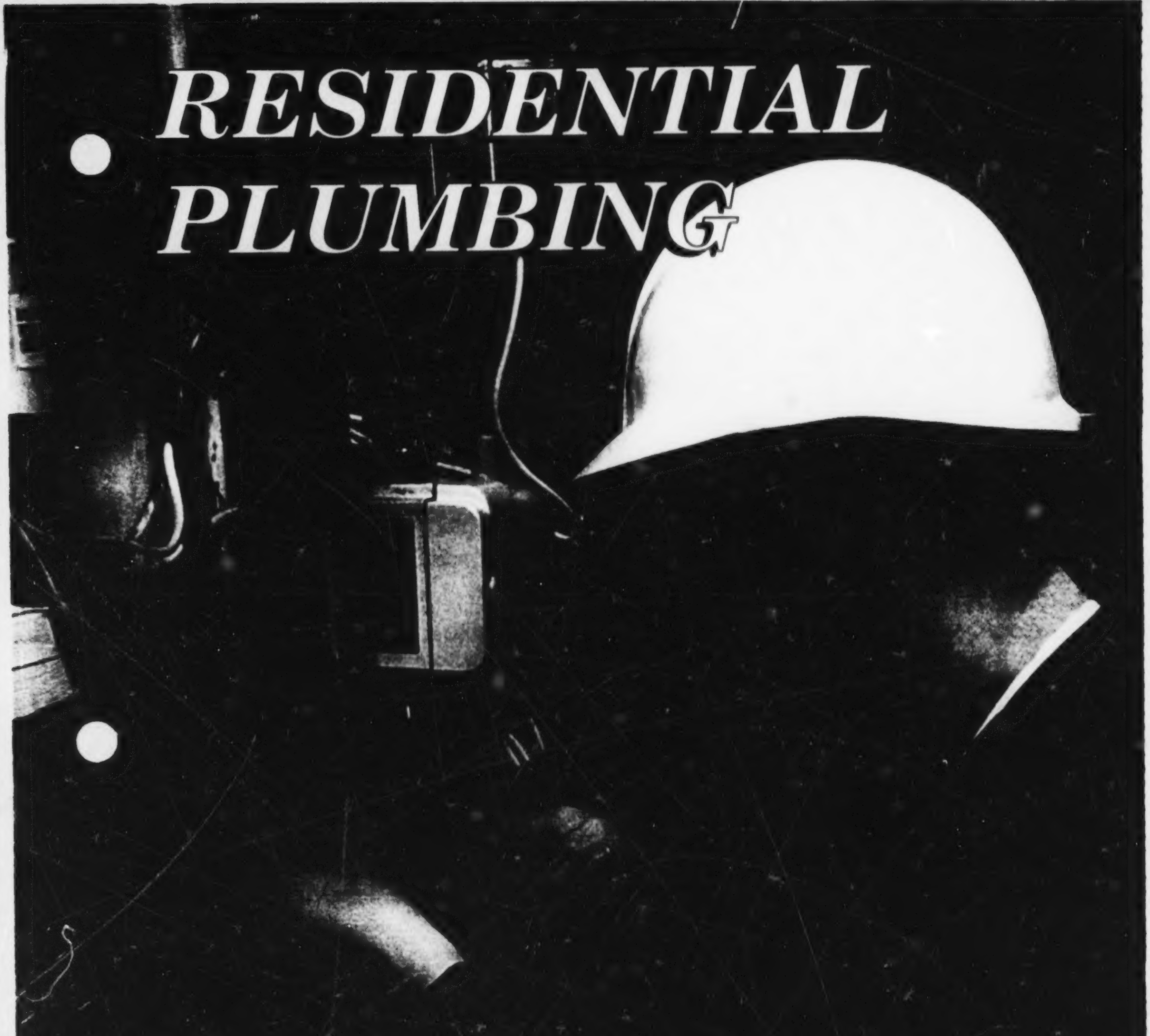
____

Teacher Signature ______________________ Date __________

Student Signature ______________________ Date __________

Permission to duplicate this form is granted.

RESIDENTIAL PLUMBING



MAVCC

Multistate Academic and
Vocational Curriculum
Consortium

Student Edition

447

Residential Plumbing

Third Edition

Student Edition

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Suzanne Belser, 1998

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Residential Plumbing

Student Edition

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Occupational Introduction
Unit 1-A

Objective Sheet

Unit Objective

After completing this unit, the student should be able to list job responsibilities and desirable characteristics of residential plumbers and select occupational fields related to residential plumbing. The student should demonstrate these competencies by completing the assignment sheet and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to plumbing occupations with their correct definitions.
2. List job responsibilities of residential plumbers.
3. Select occupational fields related to plumbing.
4. List reasons why there are occupational opportunities for residential plumbers now and in the future.
5. List desirable personality traits and attitudes for residential plumbers.
6. Explain reasons for teamwork.
7. Select conditions which enhance good customer relations.
8. Complete a chart showing the distribution of income for a residential plumbing business.
9. Interview a plumber. (Assignment Sheet 1)

Occupational Introduction
Unit 1-A

Information Sheet

1. **Terms and definitions**
    a. **Apprentice plumber**—Person who is learning the trade through an organized program of on-the-job work experience and classroom/shop training

    Note: Apprentices usually apply for licenses after a five-year training period.

    b. **Customer relations**—Attitude, interest, and/or relationship of the customer in respect to the actions of any of the employees or employers of a sales business

    c. **Journeyman plumber**—Person who installs all the plumbing systems (drainage, venting, and water) in residential structures

    d. **Master plumber**—Person who has worked as a journeyman plumber for five years before taking and passing the master plumber license exam

    e. **Plumbing contractor**—A master plumber who is licensed to perform plumbing work and who is legally capable of entering into contractual agreements with customers

    f. **Teamwork**—Work done by several persons with each doing a part but all giving attention to the efficiency of the whole project

2. **Job responsibilities of residential plumbers**
    a. Install drainage, vent, water, and gas supply pipes.

    b. Install plumbing fixtures and appliances.

    c. Perform maintenance work on existing plumbing systems.

    d. Effectively communicate with customers.

3. **Occupational fields related to residential plumbing**
    a. **Salesperson**—Retail or wholesale selling position with plumbing trade

    b. **Counter person**—Sales clerk in wholesale plumbing supply business

    c. **Estimator**—Person who develops estimated cost plus profit sheet for proposed plumbing contracts

    d. **Sales representative**—Person employed by manufacturer to aid retailers in promotion of a product

    e. **Manufacturer's representative**—Person who serves as liaison between the manufacturer and the retailer

    f. **Inspector**—Person who checks plumbing work to see if it conforms to the plumbing code

Information Sheet

g. **Foreman**—Person in charge of a specific group or crew doing plumbing work

h. **Superintendent**—Person in charge of a large job or jobs usually including several crews with foremen

i. **Building maintenance person**—Person who specializes in maintaining plumbing facilities in specific buildings

4. **Reasons why there are occupational opportunities for residential plumbers now and in the future**

a. Work is available due to continuing new home construction.

b. Service and repair work is available due to prolonged use of plumbing installations.

c. Work is available due to the continued standardization of practices through building codes, regulations, and testing.

d. Work is available due to customer demand for modern plumbing systems.

e. Work is available due to little automation in the construction field.

f. Work is available through self-employment.

5. **Desirable personality traits and attitudes for residential plumbers**

a. **Adaptability**—Adjusting to new situations

- Accept changes without complaint.
- Learn new procedures and service information.

b. **Cooperation**—Working harmoniously with others

- Observe rules and regulations.
- Help others when possible.
- Work well with co-workers, supervisor, and employer.

c. **Courtesy**—Being polite and having good manners

- Show respect for employer.
- Show respect for the customer.
- Speak clearly and pleasantly.
- Return promptly from lunch and breaks so co-workers can have their rest periods.

Information Sheet

d. **Dependability**—Doing what you say you will and completing your assigned duties

- Work regularly.
- Be on time.
- Take only the time allowed for lunch and breaks.
- Do all work assigned.
- Follow instructions.

e. **Enthusiasm**—Being eager to help or take part in some activity

- Show pride in doing job.
- Look alert.
- Do more than your share when time permits.

f. **Honesty**—Being truthful in all things

- Be careful with money.
- Give truthful information to employers, customers, and co-workers.
- Keep promises.
- Do not waste time.

g. **Initiative**—Doing things without being told

- Be productive.
- Use slack moments or leisure time to learn more about job.
- Show an interest in learning and doing a good job.
- Suggest ideas.
- Anticipate needs for a job.

h. **Loyalty**—Supporting a cause

- Keep confidences.
- Avoid public criticisms of employer, supervisor, or co-workers.
- Do not discuss wages or raises with other employees.

i. **Patience**—Taking the time to do things right

Information Sheet

j. **Self-control**—Being able to control one's temper and emotions
    - Control temper.
    - Accept objective criticism.
    - Maintain poise.

k. **Tact**—Being able to say the right thing at the right time.
    - Try to understand the needs and desires of others.
    - Do not correct customers, co-workers, or employer in a disagreeable manner.
    - Learn to take care of customer complaints.

6. **Reasons for teamwork**

a. Provides for the work to be done more quickly
b. Provides for the work to be equally shared
c. Provides for heavy loads to be handled more easily
d. Provides for a degree of comradeship rather than isolation
e. Provides for difficult jobs to be done more easily

7. **Conditions which enhance good customer relations**

a. Honesty
b. Courtesy and politeness
c. Neatness and cleanliness
d. Fairness
e. Effective communications
f. Promptness

8. **Distribution of income for a residential plumbing business**

a. Field costs—50%

Note: Field costs include such items as materials, payroll, and inspection fees.

b. Overhead—20%

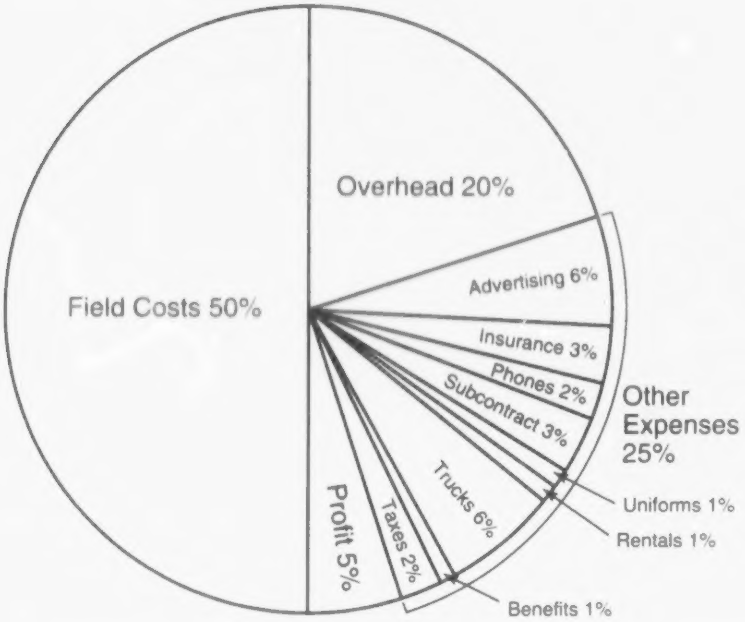
Note: Overhead includes all office expenses.

Information Sheet

c. Other expenses—25%

- Advertising—6%
- Insurance—3%
- Phones (other than office phones)—2%
- Subcontract—3%
- Uniforms—1%
- Rentals (other than office rent)—1%
- Trucks—6%
- Employee benefits—1%
- Taxes—2%

d. Profit—5%



Note: Although these percentages vary among individual businesses, they are considered typical.

Occupational Introduction
Unit 1-A

Assignment Sheet 1—Interview a Plumber

Name ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Interview questions are answered	______
• Participated in class discussion	______
• Assignment is neat and legible	______
• Assignment was completed on time	______

Directions: One of the best ways to learn about a career is to talk with a person who is working in a job similar to one you might want. Interview a plumber and complete the following questions. Be prepared to discuss your answers in class. The above criteria will be used to evaluate your performance.

Employee ______________________ Employer ______________________

1. What is your job title? ______________________

2. What are your exact responsibilities? ______________________

3. What are your usual working hours? ______________________

   How many hours do you work a week? ______________________

4. How did you find your job? ______________________

5. Does your job require a technical diploma? ______________________

   What special training did you need to qualify for this job? ______________________

Assignment Sheet 1

Where did you get the training? ____________________

6. What do employers look for in a person applying for a job like yours? ____________________

7. How long have you been with this company? ____________________

Have you worked at the same job the entire time? ____________________

8. What kind of salary can be expected working in this profession? ____________________

9. What special benefits do you get by working for this company (such as paid vacations, health insurance, etc.)? ____________________

10. Are other jobs like yours available? If so, how would you recommend learning about them?

____

11. What are the advantages of this job? ____________________

What are the disadvantages of this job? ____________________

12. What is the future outlook for the plumbing profession? ____________________

Applying for a Job
Unit 2-A

Objective Sheet

Unit Objective

After completing this unit, the student should be able to locate a job opening, make a formal application, and effectively interview for a job. The student should demonstrate these competencies by completing the assignment sheets and by scoring 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to applying for a job with the correct definitions.
2. Distinguish between employer expectations and employee expectations in their relationship.
3. List means of locating job openings.
4. List four methods of applying for a job.
5. Select personal attributes or attitudes an employer looks for during a personal interview.
6. List four items which an applicant may need to prepare when applying for a job.
7. Select guidelines to follow when interviewing for a job.
8. Write a resumé. (Assignment Sheet 1)
9. Write a letter of application for a plumbing job. (Assignment Sheet 2)
10. Complete an employment application form for a job as a plumber. (Assignment Sheet 3)
11. Practice interview questions. (Assignment Sheet 4)
12. Make an appointment by phone for a plumbing job interview. (Assignment Sheet 5)
13. Follow up an interview. (Assignment Sheet 6)
14. Evaluate a plumbing job offer. (Assignment Sheet 7)
15. Compare job opportunities. (Assignment Sheet 8)

Applying for a Job
Unit 2-A

Information Sheet

1. **Terms and definitions**

   a. **Application form**—Printed form on which job applicants record information about their personal history, job history, job experience, education, and references

   b. **Award**—Recognition received for outstanding achievement

   c. **Blind ad**—Classified advertising that does not identify the advertiser

   Note: The applicant is asked to send a letter of application and resumé to a post office box number or to call a certain number.

   d. **Employee**—Person employed by another, usually for wages or salary

   e. **Employer**—Person who employs others, usually for wages or salary

   f. **Employment agency**—Business designed to help individuals find employment

   g. **Employment/situation wanted ad**—Classified advertisement placed by individuals seeking employment and telling what their qualifications are

   h. **Equal opportunity employer**—Employer who is making a special effort to assure that no form of discrimination is practiced

   Examples: Age, sex, race, creed

   i. **Extracurricular activities**—Clubs, organizations, and social or church groups in which one participates

   j. **Fringe benefits**—Extras provided by an employer, such as paid vacations, sick leave, and insurance protection

   k. **Garnishee**—To attach wages or other property to satisfy a debt

   l. **Help wanted ad**—Classified advertisement telling what kind of job is available and what the qualifications are

   m. **Interview**—Meeting of employer and job applicant for the purpose of evaluation and questioning

   n. **Legible**—Capable of being read; clear

   o. **Qualifications**—Experience, education, and physical characteristics which suit a person to a job

   p. **Resumé**—Brief, typed summary of one's qualifications and experience that is used in applying for a job

   q. **Vocational preparation**—Any vocational courses and skills one has learned in school or through work experience

Information Sheet

2. Expectations of the employer and employee in their relationship

a. Employer expects from the employee

- Cooperation
- Honesty
- Initiative
- Willingness to learn
- Willingness to follow directions
- Dependability
- Enthusiasm
- Acceptance of objective criticism
- Loyalty and respect
- Full day's work for a full day's pay
- Notification of termination
- Productivity

b. Employee expects from the employer

- Salary
- Safe working conditions
- Training
- Introduction to co-workers
- Explanations of policies, rules, and regulations
- Notification of duty changes
- Evaluation of work
- Discipline for breaking rules
- Honest relationship
- Notification if employment is terminated
- Respect

Information Sheet

3. **Means of locating job openings**
    a. Classified ads
        - Newspapers
        - Magazines
    b. Employment offices
        - State and federal government agencies
        - Private

        Note: Most private agencies charge a fee.
    c. Local labor union business office
    d. School officials
        - Teacher
        - Counselor
        - Principal
    e. Plumbers working in your area
    f. Friends and neighbors
    g. Former employers
    h. Plumbing supply dealers
    i. Internet
        - Company job listings
        - Job search websites
4. **Methods of applying for a job**
    a. Letter
    b. Telephone
    c. In person
    d. Internet, e-mail

Information Sheet

5. **Personal attributes or attitudes an employer looks for during a personal interview**
    a. Enthusiasm and interest
    b. Dedication and dependability
    c. Alertness, quickness of mind
    d. Honesty and integrity
    e. Desire to work
    f. Ability to work well with others
    g. Desire to improve skills

6. **Items which you may need to prepare when applying for a job**
    a. Resumé
    b. Letter of application
    c. Application form
    d. Follow-up letter

7. **Guidelines to follow when interviewing for a job**
    a. Preparing for the interview
        - Be clean.
        - Be well-groomed and neat.
        - Wear appropriate clothes and shoes for the type of job.
        - Take an ink pen and resumé with the information you may need about your social security number, references, names and addresses, dates employed, and dates you attended school.
        - Go alone; do not take spouse or friends.
        - Do not be late; allow enough time.
        - Find out facts about the interviewer ahead of time.
            - Name

              Note: Make sure you have the correct pronunciation.
            - Title

Information Sheet

- Know facts about the business.
  - Name
  - Kind of business
  - Products and services
  - Reasons you want to work there
  - How old the company is and where its plants, offices, or stores are located

b. Meeting the receptionist/secretary

- Smile.
- Introduce yourself, stating that you have an appointment.

  Example: "Good morning. I am Terry McKracken and am applying for a job as a plumber. I have a 10:00 appointment with Mr. Smith."
- Follow receptionist/secretary's instructions.
- Wait patiently.

c. Starting the interview

- Smile and establish eye contact.
- Listen.
- Enter with poise.
- Greet the interviewer by name.
- Shake hands firmly.
- Introduce yourself.
- Be seated only at interviewer's invitation.
- Do not show signs of nervousness.

  Note: If you do not know where to put your hands, leave them on your lap and keep them still.
- Do not place personal things on interviewer's desk.
- Do not smoke or chew gum.
- Look alert, interested, and enthusiastic.
- Be confident.

Information Sheet

- Be courteous.

  Note: Words such as Mr., Mrs., Miss, Ms., thank you, please, and sir never go out of style.

d. Answering questions clearly during the interview

- Do not interrupt.
- Anticipate questions that might be asked and volunteer proper information.
- Explain yes and no answers.
- Avoid criticisms of former employers or competitors.
- Do not talk about personal problems.
- Answer all questions honestly.

  Examples: "The thing I liked least about my last job was that I was on the night shift and couldn't get changed to the day shift. I really wanted to be home with my family at night."

  "Truthfully, my relationship with my supervisor could have been better. We seemed to have a personality conflict and never became fond of each other. However, we did manage to work together. This was my first experience like that and I hope it doesn't happen again."

- Give positive answers to unfavorable questions.

  Example: Interviewer—"Your work experience doesn't seem to relate specifically to this job. Why do you feel qualified to fill this position?"

  Applicant—"I understand your concern. However, my job experience is broad enough to permit me to work into this particular situation. I have done work similar to this job and I think my general work record is good enough to convince you that I would be a good employee. I would be willing to receive additional training."

- Find a true, positive statement about your reasons for leaving previous jobs, even if you were fired.

  Examples: "I was laid off, but I learned from my mistakes."

  "I left because they did not need as many employees during the slow season."

- Try to mention your best qualities in relation to something concrete.

  Example: "I earned 75 percent of my expenses while going to school" is better than "I am a hard worker and want to get ahead."

- Avoid questions concerning politics, economics, religion, and other controversial subjects.

Information Sheet

- Answer questions about career objectives using specific terms about what you would like to do in the near future in that particular field without limiting your opportunities.

  Example: "I would like a position as a plumber that will lead to a supervisory position."

e. Maintaining interviewer's interest during an interview

- Look directly at the interviewer.
- Speak in clear, moderate tones.
- Use correct English.

  Note: Avoid swearing, slang terms, or annoying phrases like "yea," "you know," or "uh-huh."

- Show interest in the business; ask questions.

  Examples: Incorrect—"Listen, I need to know if you have any benefits."

  Incorrect—"Now that you've questioned me, there are a few things that I want to know before I decide if I want to work for you."

  Correct—"I wonder if you could give me some information about the benefits available to employees?"

- Sell yourself.

  Note: Never refer to yourself as just average or fair. Always look for a positive response.

- Do not get flustered.
- Give the interviewer the opportunity to mention salary and fringe benefits.
- Act enthusiastically.

f. Closing the interview

- Watch for signs that the interview is over, such as the interviewer's shuffling papers and moving around in chair.
- Ask "May I say one thing more?" or "Would you be interested in..." if the interviewer seems to be ending before all important selling points have been made.
- Thank interviewer for his/her time.

  Example: "I've enjoyed talking to you, Mr. Smith. Thank you for your time and consideration. I'm excited about this job and do hope I'm hired. Can you tell me when the position will be filled and how the applicants will be notified? (Answer) Please let me know if you need any additional information."

Information Sheet

- Learn from every situation even if the interviewer does not offer the position.

g. Following up the interview—Write a thank you letter, call, or visit again to express interest in the job and appreciation for the opportunity to interview.

Applying for a Job
Unit 2-A

Assignment Sheet 1—Write a Resumé

Name ______________________ Overall Rating ____________

Evaluation Criteria	Rating
• Directions are followed	______
• Resumé is neat, balanced, and complete	______
• Assignment was completed on time	______

Directions: Write a resumé using accurate facts about yourself. Use the information below and the sample resumé included in this assignment sheet as guides. A good resumé should immediately give prospective employers a brief summary of your accomplishments, educational background, work experience, skills, and job objective. It is not necessary to use the exact wording and outline form used on the sample resumé, but it is necessary that your resumé be neat and balanced and contain all the information which might help you get a job.

Keep a current copy of the resumé and use it to apply for jobs.

1. Inspect several resumé formats and choose one that best fits your needs, or use the example included in this assignment sheet as a guide.
2. Type your resumé on 8 1/2 x 11 inch white paper. Try not to exceed one page but attempt to fill the page.
3. Spell correctly. Many employers will not consider persons who have resumés that include misspelled words.
4. Put your name prominently at the top in the center or upper left-hand corner. Beneath name, give full street address, city, state, zip code, telephone number with area code, and a number where messages can be accepted.
5. Do not include birthplace, age, health, height, weight, sex, marital status, photo, salary, or reasons for leaving previous job. Avoid religious and political affiliations.

   Note: In general the more information you are willing to share the better; however, the whole point of the resumé is to get employers interested to meet you in person. The above information may or may not come out in the interview. By not including this information there is little chance for discrimination because of race, color, religion, sex, or national origin.
6. Describe your job objective or career goal briefly. Don't restrict yourself to a specific job unless you are experienced.

Assignment Sheet 1

7. Describe your educational background, giving dates of enrollment, diploma or degrees received, and names of schools attended. Include grade average (if favorable) and major course of study. If you include school grades, be sure they are related to the jobs you have in mind.

   Note: Applicants with less than one year of work experience should list education before work experience; with more than one year put experience first. In resumé writing, accentuate the positive, eliminate the negative. If pertinent, mention additional courses, scholarships, or summer school.

8. List your past employment, starting with your most recent job. Carefully examine all your jobs—including extracurricular activities. Concentrate on the skills: don't categorize "summer jobs."

   Note: The list should include the name of the company, your job title and your major duties. The starting and termination dates for each job should be listed. Most employers ask during interviews why you left previous jobs. Try to be positive in stating your reasons for leaving a former job. Do not downgrade your previous employers.

9. List skills useful to the job. Remember, you have to prove your value to the business, especially if you have little experience.

   Note: Use active verbs to indicate the specific tasks you performed, e.g., *built, assisted, operated.*

10. Include the following information if it is relevant and if there is enough space: hobbies and interests, extracurricular activities, clubs, awards you have received.

11. Ask at least three persons for recommendations; ask yourself the kinds of recommendations they will give you.

    Examples: Business references, teachers, character references

    Note: Avoid listing relatives unless you have actually worked for them on a salary basis.

12. Reproduce several copies of your resumé. Request white bond paper.

    Note: Your resumé's physical appearance is VERY IMPORTANT. Be sure to proofread your work.

Assignment Sheet 1

Sample Resumé

Terry McKracken

Address:

Present	Permanent
774 E. Adams Street	Route 3
Yourtown, Yourstate 77704	Anytown, Yourstate 77702
405-911-7779	405-555-4433

Job Objective: Career in plumbing leading to supervisory position in this field

Education: Anytown High School, Anytown, Yourstate 1994–98

Progress Vo-Tech, Progressville, Yourstate 1996–98
Certificate: Plumbing, four semesters
Grade average: 3.5 on a 4.0 scale

Subjects Studied:
Vocational Plumbing 1996-98, all phases of plumbing
Algebra—Two semesters
Geometry—Two semesters
Basic drafting—Two semesters
Industrial arts woodworking—Two semesters

Student Activities: Student Council Representative, Senior Class; FFA; Track Team; President, VICA 1997–98; Treasurer, Youth Fellowship Organization; Plumbing contest, First Place State, Third Place National

Work Experience:
Plumber's helper—Summer 1997
Jones Plumbing Company
600 South Main
Anytown, Yourstate 77702

References: (Listed with Permission)
Mr. Sammy Williams, Plumbing Instructor
Progress Vo-Tech
Progressville, Yourstate 77709

Mr. John Hammer, Plumbing Supervisor
Jones Plumbing Company
600 South Main
Anytown, Yourstate 77702

Mrs. Jerri Smith, Youth Director
Parkview Baptist Church
711 Fellowship Circle
Anytown, Yourstate 77702

Applying for a Job
Unit 2-A

Assignment Sheet 2—Write a Letter of Application for a Plumbing Job

Name ______________________________ Overall Rating ____________

Evaluation Criteria	Rating
• Directions have been followed	______
• Letter of application is complete and correct	______
• Assignment was completed on time	______

The application letter is a sales technique to tell the employer how your abilities will be useful to the business. The letter should specify your qualifications, while the resumé gives general background information.

Directions: Cut a help-wanted ad for a plumbing job from the classified ad section of the local newspaper. Write an application letter to accompany the resumé you prepared in Assignment Sheet 1. Use the following information and the sample as a guide.

Note: If you cannot type, write or print NEATLY using blue or black ink.

1. Use acceptable form and appearance.
   - a. Type or write neatly.
   - b. Write on only one side of the paper.
   - c. Avoid smudges and typographical errors.
   - d. Use 8 1/2" x 11" white bond paper, not personal or fancy paper.
   - e. Spell, capitalize, and punctuate correctly.
   - f. Include employer's full name, title, and address.
   - g. Include your full name and address with zip code on the letter.
   - h. Retain a copy for future reference.
2. Include proper information.
   - a. Write to a specific person.

     Note: Find out the name and correct title of the personnel manager or employer you want to reach. When in doubt, write to the top person who will refer your resumé to the right party. Use "To whom it may concern" if answering a blind ad.
   - b. Avoid excessive use of the pronoun "I."

Assignment Sheet 2

c. Be brief; do not repeat information in the resumé.

- State the position for which you are applying.
- Avoid needless details.
- Cover all points requested in the advertisement in exactly the order in which they were asked.

d. State reason for interest in job.

e. Refer briefly to the main points in the attached resumé.

f. Mention that persons listed on the resumé have given their permission to serve as references.

g. Request an interview at the employer's convenience.

- Tell where you can be reached.
- Enclose self-addressed envelope and resumé.
- Say you will phone next week.

3. Be original in your approach; attract attention in the opening paragraph.

Examples: Dear Mr. Money:

My experience as a plumber would be of interest to you....

Dear Ms. Owner:

Mr. Co-worker informed me that you are in need of a person who can be a plumber's helper. I believe that my experience and training have taught me how to handle these duties efficiently and accurately....

4. End the note properly.

Note: "Sincerely yours" or "Very truly yours" is appropriate.

5. Use permanent address for the return address and make sure to include the current date.

6. Staple letter to resumé, since it may be circulated to several departments and otherwise become detached.

7. Follow up and phone for an appointment a week later.

Note: Don't be surprised if the resumé has been referred to another department. Remember, they are in business and you may not get immediate attention, especially if you sent a blind letter. Be persistent until you reach the right person and ask for a convenient date to set up an interview.

8. Keep in touch regarding possible openings now and in the future.

Note: The "job hunt" may take several weeks or even months. It's important to keep your contacts alive without being a nuisance.

Assignment Sheet 2

SAMPLE LETTER OF APPLICATION

Route #3
Anytown, Yourstate 77702
April 15, 1998

Mr. Robert Johnson
Personnel Director
All-American Plumbing Company
Box 19
Yourtown, Yourstate 77704

Dear Mr. Johnson:

Please consider me for the plumbing job that you advertised in the *Daily Chronicle*.

The skills I have learned in my high school vocational plumbing courses should qualify me for this job. I have had experience in all of the basic skills required by the plumbing trade, including the safe use of power tools.

I will be graduating from high school in May, and will be receiving a plumbing certificate from Progress Vo-Tech. It is my goal to become a plumber and with my education and work experience as a plumber's helper, I feel I have the skills needed to be successful. A more complete description of my qualifications is given in the enclosed resumé.

I would appreciate the opportunity to come and talk with you about this position at your convenience. I can be reached by telephone at 405-555-4433 after 3:30 p.m. or at the above address.

Sincerely yours,

Terry McKracken

Enclosure

Applying for a Job
Unit 2-A

Assignment Sheet 3—Complete an Employment Application Form for a Job as a Plumber

Name ________________________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Directions are followed	______
• Assignment is complete and neat	______

Directions: Complete the following application form using the guidelines below. Use information corresponding to the classified ad and to your letter of application. Use information about yourself from your resumé.

Note: Although each business uses its own form, general rules of preparation apply to any form.

1. Be prepared.
   a. Take a good ink pen with you (dark ink).
   b. Take copies of your resumé.
2. Look over entire form before starting to write; do not hurry.
3. Follow directions.
   a. Note whether information is to be printed or handwritten.
   b. Carry out all directions.
4. Write clearly, neatly, and legibly.
5. Answer briefly.
6. Be honest.
7. Answer all questions.
8. Include complete information; use resumé.
9. Recheck application when finished.
10. Avoid cross-outs and obvious erasure marks.
11. Do not list any restrictions to the geographical area in which you would work unless you absolutely will not consider other geographical areas.
12. Use the word "open" for questions about minimum salary since most employers pay standardized rates and will not negotiate on this.

Assignment Sheet 3

"WE ARE AN EQUAL OPPORTUNITY EMPLOYMENT COMPANY. WE ARE DEDICATED TO A POLICY OF NON-DISCRIMINATION IN EMPLOYMENT ON ANY BASIS INCLUDING RACE, CREED, COLOR, AGE, SEX, RELIGION OR NATIONAL ORIGIN OR PHYSICAL DEFECTS."

APPLICATION FOR EMPLOYMENT

PERSONAL INFORMATION

DATE

NAME
LAST FIRST MIDDLE

PRESENT ADDRESS
STREET CITY STATE ZIP

PERMANENT ADDRESS
STREET CITY STATE ZIP

PHONE NO. SOCIAL SECURITY NUMBER

REFERRED BY

EMPLOYMENT DESIRED

POSITION DATE YOU CAN START SALARY DESIRED

ARE YOU EMPLOYED NOW? IF SO, MAY WE INQUIRE OF YOUR PRESENT EMPLOYER

EVER APPLIED TO THIS COMPANY BEFORE? WHERE WHEN

EDUCATION	NAME AND LOCATION OF SCHOOL	YEARS ATTENDED	DATE GRADUATED	SUBJECTS STUDIED
GRAMMAR SCHOOL				
HIGH SCHOOL				
COLLEGE				
TRADE, BUSINESS, OR CORRESPONDENCE SCHOOL				

SUBJECTS OF SPECIAL STUDY OR RESEARCH WORK

U.S. MILITARY OR NAVAL SERVICE RANK PRESENT MEMBERSHIP IN NATIONAL GUARD OR RESERVES

ACTIVITIES OTHER THAN RELIGIOUS (CIVIC, ATHLETIC, FRATERNAL, ETC.)

Exclude organizations, the name or character of which indicates the race, creed, color, or national origin of its members.

(CONTINUED)

Assignment Sheet 3

FORMER EMPLOYERS (LIST BELOW LAST THREE EMPLOYERS, STARTING WITH LAST ONE FIRST.)

DATE MONTH & YEAR	NAME AND ADDRESS OF EMPLOYER	SALARY	POSITION	REASON FOR LEAVING
FROM				
TO				
FROM				
TO				
FROM				
TO				

REFERENCES: Give below the names of persons not related to you, whom you have known at least one year.

NAME	ADDRESS	BUSINESS	YEARS ACQUAINTED
1			
2			

I AUTHORIZE INVESTIGATION OF ALL STATEMENTS CONTAINED IN THIS APPLICATION. I UNDERSTAND THAT MISREPRESENTATION OR OMISSION OF FACTS CALLED FOR IS CAUSE FOR DISMISSAL. FURTHER, I UNDERSTAND AND AGREE THAT MY EMPLOYMENT IS FOR NO DEFINITE PERIOD AND MAY, REGARDLESS OF THE DATE OF PAYMENT OF MY WAGES AND SALARY, BE TERMINATED AT ANY TIME WITHOUT ANY PREVIOUS NOTICE.

DATE

DO NOT WRITE BELOW THIS LINE

INTERVIEWED BY DATE REMARKS

NEATNESS		CHARACTER	
PERSONALITY		ABILITY	

HIRED FOR DEPT. POSITION WILL REPORT SALARY WAGES

APPROVED: 1. 2. 3.

EMPLOYMENT MANAGER DEPT. HEAD GENERAL MANAGER

Applying for a Job
Unit 2-A

Assignment Sheet 4—Practice Interview Questions

Name ______________________________ Overall Rating ____________

Evaluation Criteria	Rating
• Directions are followed	______
• Conducted mock interview	______

Directions: The following are some additional questions which you might be asked when applying for various jobs. Keep the assignment sheet to review before going on any actual interview. After you have studied the questions, conduct a mock interview for a plumbing job with one of your fellow students.

Note: Questions about your personal life may not be legally asked. In fact, it is illegal for an employer to ask your maiden name or your father's surname if you are a female applicant; your marital status; who lives with you; the church you attend or the name of your spiritual leader; how many children you have, their ages, or who will care for them while you are at work; whether you own or rent your residence; whether you have ever had your wages garnished; and whether you have ever been arrested. However, many interviewers, particularly in small businesses, may ask such questions. Whether or not you choose to answer the questions depends on you.

How would you answer the following questions? Why do you think each question might be asked?

1. Where do you go to school? When will you graduate?
2. Do you (did you) earn any of your own expense money while in school?
3. Why did you leave your previous job(s)?
4. What did you like best and what did you like least about your classes?
5. What books have you read lately? What are your favorite magazines?
6. Are you in good health?
7. What do you expect to be doing five or ten years from now? What is your chosen field of work?
8. At what salary do you expect to start?
9. What are some of your special abilities? What skills do you possess? What tools or equipment can you operate?
10. How would you rate your training for this job? Excellent? Very good? Fair?
11. What personal characteristics do you think are needed to succeed in your vocation?
12. In what area do you need the most improvement?

Assignment Sheet 4

13. Do you like to work with other people or do you work best alone?

14. Do you have any questions you want to ask us?

15. Do you think your extracurricular activities were worth the time you devoted to them?

16. How could you contribute to our organization? Why should we hire you?

17. Tell us about your family and any plans for marriage or further education.

    Note: Legally, you do not have to answer this question. However, it is a good idea to prepare an answer in case such a question is asked.

18. For what other jobs have you applied?

19. Do you have any military obligations to fulfill?

20. Give us an example of a project you finished under pressure.

21. May we write or call your last employer?

22. How many people have you supervised at work or through organizations of which you are a member?

23. How do you feel about working overtime?

24. Would you be able to work all day Saturday and Sunday?

25. If you could start school (or work) over again, what would you do differently?

26. What is your school attendance record?

27. Have you done the best school work of which you are capable?

28. Do you require attention? Does criticism disturb you?

    Note: These questions are usually asked in a more subtle and indirect way.

29. What motivates you?

30. Would you be willing to relocate?

31. Define *cooperation.*

REMEMBER: YOU NEVER GET A SECOND CHANCE TO MAKE A GOOD FIRST IMPRESSION!!!
GETTING A JOB IS A JOB!!!

Applying for a Job
Unit 2-A

Assignment Sheet 5—Make an Appointment by Phone for a Plumbing Job Interview

Name ______________________________ Overall Rating ______________

Evaluation Criteria	**Rating**
• Directions are followed	______
• Made appointment for interview	______

Introduction: Making an appointment by phone does two things. First, it shows that you are interested in saving the employer's time. Second, it shows that you are thoughtful for asking what would be the best time for you to see the employer.

1. Steps in making an appointment by phone

   a. Plan what you are going to say before you call.

   b. State your name and reason for calling.

      Example: "Hello, this is Terry McKracken. I'm calling you about your ad in last night's paper for a plumber. May I have an appointment for an interview?

   c. Ask when would be the best time for you to come for the interview.

   d. Record the day, time, and place of the interview.

   e. Thank the receptionist for the help.

2. Things to remember when calling for an appointment

   a. Keep the receptionist on your side; the receptionist is there to help you.

      Note: The receptionist is sometimes asked to evaluate the applicant.

   b. Do not ask over the phone how much the job pays.

   c. Be polite and courteous.

      Note: Remember that this call is the first contact you may have with the firm. Make that first impression a good one.

   d. Ask if you should pick up an application blank or if they would like to send it to you before the interview.

Assignment Sheet 5

Directions: Now that you have read about the correct way to arrange for an employment interview, role play a situation where you make an appointment by phone. Use the checklist below to evaluate your performance.

	Yes	No	If no, explain
Were you prepared before calling?			
Comments:			
Did you not have to stammer to find the right words?			
Comments:			
Did you identify yourself immediately?			
Comments			
Did you state your reasons for calling immediately?			
Comments:			
Did you ask the best time for an appointment with employer?			
Comments:			
Were you courteous and friendly?			
Comments:			
Did you ask about picking up application blank or having application blank sent prior to interview?			
Comments:			
Did you thank the receptionist?			
Comments:			
Did you make a record of the interview date, hour, and place?			
Comments:			

Applying for a Job
Unit 2-A

Assignment Sheet 6—Follow Up an Interview

Name ______________________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Followed guidelines for a follow-up telephone call and spoke in a clear, concise manner	______
• Follow-up letter free of errors	______
• Assignment is neat and completed on time	______

Introduction: It is sometimes helpful to return to a business and check again on possible job openings. This is often done about a week after the first interview. This short, casual visit accomplishes two things. It helps the interviewer remember you, and it shows that you have a sincere interest in working for that company.

However, it is not always possible to have this type of informal atmosphere when applying for a job. In that case, it is always proper to send a follow-up letter or to make a follow-up telephone call.

Part 1

Directions: Role play a follow-up telephone call using the guidelines below.

1. Make sure you include the following information:
   a. Your name
   b. Date of your interview
   c. Position for which you were interviewed
2. Ask whether a decision has been made.

   Example: "Hello, Mr. Jones. This is Terry McKracken. I interviewed with you on April 22 for the position of a plumber. Have you made a decision on my application yet?"
3. If someone has already been hired, thank the interviewer for considering you, and express interest in working for the company.

   Example: "I'm sorry I wasn't hired, but thank you for at least considering my application. I am still interested in working for your company and would appreciate your keeping my application on file."

Assignment Sheet 6

Part 2

Directions: Write a follow-up letter thanking the employer for the interview. Use any form you wish or follow the format of the sample follow-up letter included in this assignment sheet.

1. Make sure your letter meets the following standards:
    a. Typed or written perfectly
    b. Clean, neat, and attractively arranged on the page
    c. Free from spelling, punctuation, and grammatical errors
    d. Sent within a day or two after the interview
2. Include the following points in your follow-up letter:
    a. Expression of appreciation for interviewer's time and interest
    b. Summary of your qualifications and interest in the position
    c. Your name, address, and phone number (to make it easier for the employer to contact you)
3. Make this last bid for the job a prime example of your excellent work habits; make the letter clean, neat, and well-worded.

Assignment Sheet 6

SAMPLE FOLLOW-UP LETTER

Route #3
Anytown, Yourstate 77702
May 1, 1998

Mr. Robert Johnson
Personnel Director
All-American Plumbing Company
Box 19
Yourtown, Yourstate 77704

Dear Mr. Johnson:

Thank you for interviewing me for the plumbing job with your company. I feel that working for All-American Plumbing Company would be enjoyable and that I could do the general plumbing work that the job requires. I hope that I will have the opportunity to prove my worth.

The application form you gave me is enclosed.

I will be available for work June 1. You may call me at my home after 3:30 p.m. The number is 405-555-4433.

Sincerely yours,

Terry McKracken

Enclosure

Applying for a Job
Unit 2-A

Assignment Sheet 7—Evaluate a Plumbing Job Offer

Name ______________________ Overall Rating ______________

Evaluation Criteria	**Rating**
• Directions are followed	______
• All questions are answered	______
• Assignment is neat and completed on time	______

Introduction: Instead of saying "yes" or "no" on the spot to a job offer, express your gratitude in a warm and friendly manner, and then ask if you may have time to consider the opportunity you have been offered. Few reputable employers will deny you a reasonable time to be certain before agreeing to a job.

Avoid getting stuck with a job that's wrong for you by using the following checklist to evaluate the job offer.

Directions: Use the questions below to evaluate a job that you may be considering or one designated by your instructor. Write your answers on a separate sheet of paper.

The job...

1. Do I clearly understand the nature of the work, and is it what I want to do? Are my responsibilities reflected in the job title?
2. If this isn't my dream job, can it be a stepping stone as I acquire the skills and experience needed for advancement?
3. Is the background I'm building so narrow that I will have difficulty transferring it to another employer?
4. Will I be able to make any decisions affecting my work? Does it make a difference?
5. Will I need more training and will the company pay for it?
6. Will overtime be necessary or available?
7. Will I be able to leave all thought of the job behind at day's end? If not, do I care?
8. Will I have to travel or relocate?
9. Is the job permanent or temporary?
10. If permanent, is the job reasonably secure?
11. Does this job require union membership?

Assignment Sheet 7

The company...

1. Is the firm too large and heavy with rules for my personality?
2. Is the firm too small to offer room for advancement or impressive credentials for a future resumé?
3. Does the firm have a healthy financial position, and is it a growing organization?
4. Is there a high turnover of personnel, and if so, why?
5. Does the firm promote from within the ranks or turn to outsiders to fill supervisory jobs?
6. Have I met the person who would be my immediate supervisor?
7. Does the supervisor seem like the sort of person with whom I could get along?
8. Do co-workers appear to be my kind of people?
9. Is the company's location convenient?
10. What is the firm's reputation for fair treatment of employees?
11. Does a written personnel statement cover vacations, sick leave, cause for dismissal, and so forth?

Financial rewards...

1. Do the earnings meet my minimum needs? Are there automatic cost-of-living increases?
2. What is the method of payment—salary, hourly wage?
3. Are raises based on merit, length of service, formal exams?
4. What fringe benefits are given—health insurance, free parking, discount privileges, and others?

When to say no...

Should you always turn down an offer that doesn't measure up?

That depends on several questions. How desperately do you need to earn money? How competitive is the field you hope to enter, and would it be best to get your foot in the door any way you can? How valuable is the experience you'll gain? Sometimes it is wise to accept a job which is not perfect in your eyes. Other times, it might be best to refuse the offer.

Applying for a Job
Unit 2-A

Assignment Sheet 8—Compare Job Opportunities

Name ______________________________ Overall Rating ______________

Evaluation Criteria	**Rating**
• Directions are followed	_______
• All questions are answered	_______
• Assignment is neat and completed on time	_______

Introduction: When you are offered a job or are changing jobs, you must weigh many factors before taking the position. Some of these include:

- What is your take-home pay?
- What benefits accompany the job?
- How much will it cost to actually be at work each day?
- Would the job be satisfying to you?
- How would the job meet your needs and aspirations?

Take-Home Pay

Employers often quote salaries and wages as gross earnings. Gross earnings are used because tax deductions vary due to the number of dependents, the amount of earnings, and other information.

Optional benefits and deductions offered by an employer can also differ. It is generally advisable to ask what programs are available for enrollment as these can affect the actual money you receive on pay day.

Other Benefits

Some benefits associated with working are not always visible. Often some of these overlooked benefits are paid for in part by your employer. At the time of the interview or when considering a position, ask about employer's contributions for your protection which may include:

1. Health insurance
2. Unemployment compensation
3. Uniforms and meals
4. Medical facilities and health tests
5. Pensions

Assignment Sheet 8

6. Travel insurance (covering mishaps when traveling on business)
7. Educational programs or reimbursement for courses related to position
8. Sick leave with pay
9. Paid vacations and holidays
10. Social security
11. Worker's compensation

Part 1—Costs Associated with Employment

Directions: We often overlook the costs associated with being employed. It may be of value to calculate estimated weekly expenses before you make a decision about an employment offer. Estimate weekly expenses for a job you may be considering or one designated by your instructor.

Transportation (parking, bus fares) $ ____________

Lunches (or cost of food eaten away from home, including soft drinks and coffee) $ ____________

Clothing (including cleaning) $ ____________

Child care for working parent $ ____________

Special uniforms, materials, or equipment $ ____________

On the job expenses $ ____________

Other $ ____________

TOTAL $ ____________

Assignment Sheet 8

Part 2—Other Important Considerations

Directions: Take-home pay and benefits may be only part of what you want from being employed. Think through other things you consider important. What are some of the most rewarding things you have felt about any position you have ever had? Write your answers in the blanks provided.

1. ____________________
2. ____________________
3. ____________________

Directions: Rate the following job aspects in order of their importance to you.

Note: "1" should be most important.

______ Job security (little chance you'll be released from the job)

______ Opportunity for advancement

______ Recognition for your work

______ Good wages

______ Opportunity to learn and use your ideas

______ Flexible working hours

______ Long vacations

______ Pleasant working conditions

______ Interesting work

______ Friendly co-workers

______ Travel

______ Other ____________________

Assignment Sheet 8

Part 3—Time to Decide

Directions: Using the information and ratings you have compiled in this assignment sheet, answer the following questions to help you reach a decision about whether you want a specific job.

1. Would the job be satisfying to me? Why/why not?

____

____

____

2. What benefits accompany the job?

____

____

____

3. How much will it cost to actually be at work each day?

____

____

____

4. How would the position meet my needs and aspirations?

____

____

____

5. I estimate my take-home pay to be $ ______________________________

6. I estimate my expenses related to working to be $ ______________________________

7. I would most enjoy the following about this position:

____

____

____

8. I estimate my job benefits to be worth $ ______________________________.

9. Based on the information above, I ______________ (would/would not) accept the position.

General Safety and First Aid
Unit 3-A

Objective Sheet

Unit Objective

After completing this unit, the student should be able to recognize unsafe situations in the shop, interpret a material safety data sheet, and analyze problems related to shop safety and first aid. The student should demonstrate these competencies by completing the assignment sheets and job sheets and by scoring a minimum of 100 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to general safety and first aid with their definitions.
2. Select true statements concerning things OSHA expects of an employer.
3. Select true statements concerning things OSHA expects of an employee.
4. Select true statements concerning basic first aid procedures for emergency situations.
5. Match colors of the safety color code with their applications.
6. Complete statements concerning rules for personal safety.
7. Select true statements concerning rules for general shop and field safety.
8. Complete statements concerning characteristics of a clean and orderly shop.
9. Match classes of fire with their descriptions.
10. Label the components of the fire triangle.
11. Match types of fire extinguishers with the classes of fire they are designed to extinguish.
12. Match fire extinguisher symbols with their meanings.
13. Select steps to be followed in case of an accident.
14. Complete statements concerning guidelines for lifting and carrying items safely.
15. Complete statements concerning purposes of a material safety data sheet (MSDS).
16. Interpret a material safety data sheet. (Assignment Sheet 1)
17. Analyze problems related to shop safety and first aid. (Assignment Sheet 2)
18. Operate a fire extinguisher. (Job Sheet 1)
19. Lift a heavy object properly. (Job Sheet 2)

General Safety and First Aid
Unit 3-A

Information Sheet

1. **Terms and definitions**

   a. **Accident**—Any suddenly occurring, unintentional event which causes injury or property damage

   b. **Cardiac arrest**—Stoppage of the involuntary beating of the heart

   c. **Cardiopulmonary resuscitation** (CPR)—Procedure for restoring breathing after cardiac arrest

   Note: CPR training procedures are beyond the scope of this course.

   d. **Carelessness**—Failure to think before one acts; failure to pay attention

   e. **First aid**—Immediate, temporary care given to the victim of an accident or sudden illness until the services of a physician can be obtained

   f. **First-degree burn**—Burn affecting only the outer skin layers; characterized by redness and pain

   g. **Grounded**—Electrical connection to an object that conducts electrical current to the earth

   h. **OSHA** (Occupational Safety and Health Act)—Federal legislation designed to insure safe and sanitary working conditions for employees

   i. **Safety**—State or condition of being safe; freedom from danger, risk, or injury

   j. **Second-degree burn**—Burn penetrating beneath the superficial skin layers; characterized by swelling and blisters

   k. **Shock**—Medical condition in which the operation of the circulatory system is partially or completely impaired by the body's reaction to injury or psychic disturbance

   l. **Third-degree burn**—Burn that destroys all skin layers and underlying tissue; characterized by charring or white, leathery appearance of the skin and absence of pain

   Note: Third-degree burns are not painful because nerve tissue has been destroyed. Third-degree burns are the most severe and many times can be life threatening, requiring lengthy treatment and skin grafts.

2. **Things OSHA expects of an employer**

   a. Provide a hazard-free workplace and comply with occupational safety and health standards.

   b. Inspect job sites to assure they meet safety standards.

   c. Use properly color-coded signs to warn of danger.

Information Sheet

d. Obtain a material safety data sheet (MSDS) for each hazardous chemical present in the workplace and make sure any chemical containers are properly labeled and that MSDSs are readily accessible to employees.

e. Formulate and implement a training program for employees that informs them of any and all chemical substances to which they are exposed and trains them in the proper handling of such substances.

f. Keep required records of work-related injuries and post an annual summary in February of each year.

g. Report to OSHA within 48 hours any accident which is fatal or hospitalizes five or more workers.

h. Post in a prominent place OSHA poster #2203 informing workers of their rights and responsibilities.

3. Things OSHA expects of an employee

a. Read the OSHA poster #2203 and comply with its standards.

b. Follow employer safety and health rules and wear prescribed clothing or protective equipment on the job.

c. Report any hazardous conditions to a supervisor.

d. Report all job-related injuries to a supervisor and seek prompt treatment if required.

e. Report to OSHA in a responsible manner any hazardous working situations which you feel the employer has not attended to properly.

4. Basic first aid procedures for emergency situations

Note: A basic first aid kit should be carried in the plumber's truck.

Caution: Given the increased awareness of diseases carried by bloodborne pathogens, hepatitis B (HBV), human immunodeficiency virus (HIV) and others, the U.S. Department of Labor advises that universal precautions be observed any time blood or other human body fluid is present. This precaution requires employers and employees to assume that all human blood and specified human body fluids are infectious for HIV and HBV and other bloodborne pathogens. Where it is impossible to determine the type of body fluid present, all body fluids are to be considered potentially infectious.

a. Bleeding

- Minor bleeding—Apply antiseptic solution or cream and dress wound with sterile bandages.
- Severe bleeding—Elevate the wound and apply pressure dressing or manual pressure to the wound.

Information Sheet

b. Burns

- Chemical—Flush skin thoroughly with clean water and seek medical attention.
- Electrical—Locate both the entrance and exit burns; cool with a damp compress, then cover with dry sterile dressing; cover the victim with a blanket and elevate the feet and legs to prevent shock and loss of body heat.
- First-degree—Hold under cold water, then apply dry sterile dressing.
- Second-degree—Cool with a damp compress, taking care not to break the blisters, then cover with a dry, sterile dressing to prevent infection.
- Third-degree—Cool with a damp compress and then cover with a dry sterile dressing; cover the victim with a blanket, elevate feet and legs to prevent shock and loss of body heat.

c. Traumatic shock

Note: Traumatic shock may occur within any time period following an injury. Although the injury itself may not be life threatening, the onset of shock resulting from the injury can be fatal.

- Recognize signs and symptoms of traumatic shock.
    - Early stages

      Pale or bluish skin that is cool to touch
      Moist, clammy skin if perspiration has occurred
      General weakness
      Rapid, weak pulse
      Rapid, shallow, possibly irregular breathing
      Restlessness or anxiety
      Vomiting or nausea
      Excessive thirst
    - Late stages

      An attitude of not caring
      Unresponsiveness
      Sunken eyes with dilated pupils
      Spotty or mottled appearance of skin; bluish color to lips and nailbeds
      Low body temperature; cool clammy skin
      Loss of consciousness leading to death if untreated
- Lay victim down.
- Elevate victim's legs slightly.
- Cover to prevent loss of body heat.

  Note: In some cases it may be necessary to have someone lie in close contact with the victim to conserve body heat.

Information Sheet

d. Falls

- Head injury—Lay victim flat, then control bleeding and shock.
- Less severe falls—Check for injury and provide first aid as appropriate; do not move victim or allow victim to move if a neck or back injury is suspected.

  Caution: If either neck or back is broken, moving the victim could sever or damage the spinal cord, causing immediate death or paralysis.

e. Electrical accident

Caution: If the victim is still in contact with a live electrical circuit, do not endanger yourself by touching the victim, or metal objects, water, or wet ground. You may become a victim yourself as the current passes through your body. Death can be instantaneous.

- Do not provide any assistance until all electrical current has been shut off.
- Administer CPR if necessary.
- Treat for traumatic shock.
- Treat for electrical burns

  Note: Always look for the entrance wound and exit wound of an electrical burn. Both may resemble a bull's-eye consisting of a central charred zone, a middle zone of gray tissue, and an outer red zone.

f. Heat exhaustion

- Recognize the signs and symptoms of heat exhaustion:
  - Profuse perspiration
  - Pale, clammy skin
  - Rapid, weak pulse
  - Rapid, shallow breathing
- Immediately move victim to a cool place.
- Lay victim flat.
- Elevate victim's feet slightly.
- Remove as much of the victim's clothing as possible.
- Sponge victim with cool water.

Information Sheet

g. Heat stroke

Note: Heat stroke is a true emergency. Act quickly or the victim will suffer brain damage or death.

- Recognize the signs and symptoms of heat stroke:
    - Little or no perspiration
    - Hot, flushed skin
    - Rapid, weak pulse
    - Rapid, shallow breathing
- Move victim immediately to a cool location.
- Cool victim as quickly as possible.

  Note: Do not take time to remove a victim's clothing until after initial cooling, such as spraying the victim with a garden hose, pouring the contents of a drinking water container over victim, or immersing victim in a nearby stream or pond.
- Rub ice on victim's extremities.

h. Mild hypothermia

- Recognize the signs and symptoms of **mild** hypothermia:
    - Shivering
    - Complaints of being cold
    - Loss of coordination
    - Psychological withdrawal and apathy
- Get the victim out of cold, wet conditions.
- Replace wet clothing with dry clothing, or add insulation.
- Place victim in warm environment.
- Offer warm liquids or food only if victim is fully conscious.

i. Moderate hypothermia

- Recognize the signs and symptoms of **moderate** hypothermia:
    - Listlessness, mental confusion, refusal to recognize problem
    - Uncontrollable shivering
    - Slurred speech
    - Stumbling

Information Sheet

- Cover victim at the site rather than walking to shelter.
- Treat victim gently and avoid unnecessary jostling or movement.
- Do not allow victim to exercise or move.
- Check victim for other injury, including frostbite.

j. Severe hypothermia

- Recognize the signs and symptoms of **severe** hypothermia:
  - Unresponsiveness
  - Decreased pulse and respiration
  - Cessation of shivering
  - Physical collapse
- Treatment should be attempted only if victim cannot be evacuated for professional emergency care.
- Deliver warmth to head, neck, armpit, and groin areas by application of warm water bottles, warmed blankets, or another warm body.

k. Animal bite

Note: First aid for animal bites is similar to any other wound, except for the need to be aware of the possibility of rabies infection.

- Cleanse wound thoroughly with soap and water; apply antiseptic.
- Cover bite wound with a sterile dressing and bandage.
- Seek medical attention, especially if the bite is on the face, head, or neck areas.

l. Insect stings

Note: In case of a bee sting, the insect's stinger likely will still be imbedded in victim's skin. Scrape stinger sideways to remove. Never pinch the stinger to remove as this actually will inject more toxin into the wound.

- Ordinary reaction—Wash wound with soap and water and apply ice to reduce swelling
- Allergic reaction

  Note: A victim with an allergic reaction to a bee sting is suffering from anaphylactic (respiratory arrest) shock and needs prompt treatment with epinephrine by injection or inhalation.

Information Sheet

- If possible, immediately evacuate the victim to a hospital or physician's office.

  Note: Have someone call ahead to notify the party of the situation and your planned arrival.

- If transportation is not immediately available, lay the victim down or help the victim to a position in which he or she can breathe more easily.
- Elevate the victim's legs if possible.
- While waiting for emergency aid, remove the stinger and perform first aid actions for an ordinary sting.

m. Snake bite

- Nonpoisonous
  - Cleanse wound with plain water and soap.
  - Cover with sterile dressing.
  - Seek medical attention.
- Poisonous—Pit viper

  Note: Within the medical community there is a vigorous controversy over the advisability of using antivenin injections in the treatment of snake bites originating from copperheads, rattlesnakes, and cottonmouth (water moccasin). Although in the case of the coral snake, antivenin treatment is recommended, because of the conflicting opinions on the use of similar materials for pit viper bites, professional medical assistance is advisable and decisions on the use of antivenin should be left up to those professional individuals.

  - Immobilize the victim.
  - Have him or her lie down, and keep quiet.
  - Do not give victim liquor.
  - Apply a constricting band about the affected appendage just above the fang marks as soon as possible.

    Note: Under no circumstances should the constricting band be tight enough to block venous or arterial blood flow. Also, as edema (tissue swelling due to concentrations of water and waste material) builds, the band should be moved further from the wound periodically.

  - Apply suction as quickly as possible to wounds to remove venom.

Information Sheet

Note: Suction cups, "Extractor" devices, and mouth suction (be aware of cautions on bloodborne pathogens) are recommended to remove as much venom as possible. Suction should be continued up to four hours after the bite, although the amount of venom removed by this method will be sharply reduced after the first 15 minutes. Still, as pit viper venom degenerates tissue and blood cells near the wound, suction removal of this waste material will be helpful in preventing the victim's body from having to filter this material through the lymphatic and renal systems.

— Apply hot and cold compresses, alternated every three to five minutes.

Note: Raising the temperature of venom tends to break it down, and lowering temperatures tend to cause the capillary system to contract. The continual differing stimuli help provide fresh oxygenated blood flow to the wound area and tend to prevent additional tissue damage.

— Seek medical attention at once.

- Poisonous—Coral snake

Note: The venom of the coral snake is similar to that of the cobra in that it attacks the nervous system, unlike venom of pit vipers which attacks the blood and circulatory system. Because of this immediate medical attention and administration of antivenin is necessary. Death can come rapidly.

— Immobilize the victim. Have him or her lie down and keep quiet.

— Apply arterial tourniquet (tight enough to stop blood flow) up to 30 minutes.

— Seek medical attention at once for antivenin administration.

n. Tick bites

- Carefully remove an imbedded tick with tweezers by grabbing the tick as close to the skin as possible and pulling gently straight out.

Note: Removing the tick with the thumb and forefinger carries the risk of crushing the tick and actually injecting the victim with the juices of the tick.

- Wash area with soap and water.
- Use a topical antiseptic and be alert for signs of tick-borne diseases for several weeks.

Note: Some ticks are carriers of Lyme disease and Rocky Mountain Spotted Fever.

o. Spider bites

- Apply cold water or ice; a topical antiseptic may be used; take aspirin or acetaminophen for pain; and rest.

Note: The bite of either the black widow or brown recluse spider is highly toxic and dangerous. If bitten by either of these species (or if you are not certain of the biting spider's identification) seek medical attention at once.

Information Sheet

5. **Colors and application of the safety color code**

   a. Safety red

   - Location of fire fighting equipment
   - Portable containers of flammable liquids
   - Emergency stop bars, stop buttons, and emergency electrical stop switches on machinery

   b. Safety yellow

   - Caution and for marking physical hazards
   - Waste containers for explosive or combustible materials
   - Caution against starting, using, or moving equipment under repair
   - Identification of the starting point or power source of machinery

   c. Safety orange

   - Dangerous parts of machines
   - Safety starter buttons and parts of equipment that may cause electrical shock
   - Exposed parts (edges only) of pulleys, gears, rollers, cutting devices, and power jaws

   d. Safety purple—Radiation hazards

   e. Safety green

   - Safety
   - Location of first aid equipment

     Note: This applies to equipment other than fire fighting equipment.

   f. Safety blue—Caution against starting equipment while it is being worked upon

   Note: A blue tag should be lettered "Out of Order."

   g. Safety black, white, or combination of black and white

   - Traffic flow
   - Housekeeping purposes

Information Sheet

6. Rules for personal safety

a. Wear appropriate clothing for the activity being performed. Check for flammability of synthetic materials.

b. Remove all ties and confine loose fitting clothes when working around machine tools or rotating equipment.

c. Confine long hair before operating equipment.

d. Always wear safety glasses to protect eyes.

e. Wear laser safety goggles when operating a laser.

f. Wear filter lenses and face shield for welding, soldering, and brazing.

g. Remove all jewelry when working in the shop.

h. Conduct yourself in a safe manner.

i. Wear ANSI approved safety helmet in areas of potential danger of head injuries.

j. Use soap and water frequently as a method of preventing skin irritation.

k. Wear gloves when handling material with sharp edges.

7. Rules for general shop and field safety

a. Tools and equipment

- Keep all hand tools sharp, clean, and in safe working order.
- Report all defective tools, machines, or other equipment to your supervisor.
- Use grounded electrical tools that are equipped with a three-prong plug.
- Observe proper safety precautions when setting up and using ladders and scaffolding.
- Operate machinery only after receiving instruction on how to operate the machine safely.
- Turn off power before leaving a power tool.
- Make sure all guards and barriers are in place and adjusted properly before starting a machine tool.
- Turn off and disconnect the power from tools and equipment before performing the maintenance task of oiling or cleaning.
- Use correct, properly fitting wrenches for nuts, bolts, and objects to be turned or held.
- Use the proper tool for the proper job.

Information Sheet

- Do not leave tools on floor.
- Do not run over extension or drop cords with heavy equipment.
- Do not use power tools in damp areas or near combustible materials.
- Do not throw tools or other objects.

b. Accidents and safety

- Use a solvent only after determining its properties and how to use it.
- Use chemical solvents in well-ventilated areas and avoid inhaling vapors.
- Wear respiratory protection when exposed to gas or vapor.
- Use shoring, sloping of ground, or trench boxes on walls and faces of excavations.
- Locate and protect underground utilities before excavating and trenching.
- Report to your supervisor any condition that may lead to an accident.
- Know locations of first aid stations.
- Know locations of emergency shower/eyewash.
- Do not work in the dark or in poorly lit areas; use plenty of light.
- Report to your supervisor all accidents, regardless of nature or severity.
- All accidents should be recorded in writing.
- Do not distract attention of a machine operator while working.
- Do not work overtime in the shop without your supervisor's knowledge.
- Do only approved work in the shop.
- Make sure the area is clear when using compressed air.
- Operate equipment and machines only when permitted by your supervisor.
- Clean chips from machine with a brush; do not use a towel, bare hands, or compressed air.

8. Characteristics of a clean and orderly shop

a. Machinery and equipment arranged to permit safe, efficient work practices and ease in cleaning

b. Materials and supplies safely stacked or stored in proper places

c. Tools and accessories safely stored in cabinets, on racks, or other suitable devices

Information Sheet

d. Working areas and work benches clear and free of debris and other hazards

e. Floors clean and free from obstructions and slippery substances

f. Aisles, traffic areas, and exits free of materials and other debris

g. Combustible materials properly disposed of or stored in approved, labeled containers

h. Oily towels stored in approved metal containers

i. Employees working in the area instructed on the proper procedures to follow in keeping the area clean and orderly

j. Sufficient brooms, brushes, and other housekeeping equipment readily available

k. Drinking fountain and wash facilities clean and neat at all times

9. Classes of fires

a. Class A—Fires that occur in ordinary combustible materials such as wood, paper, rags, and rubbish

b. Class B—Fires that occur with flammable liquids and gases such as gasoline, oil, grease, paints, thinners, and solvents

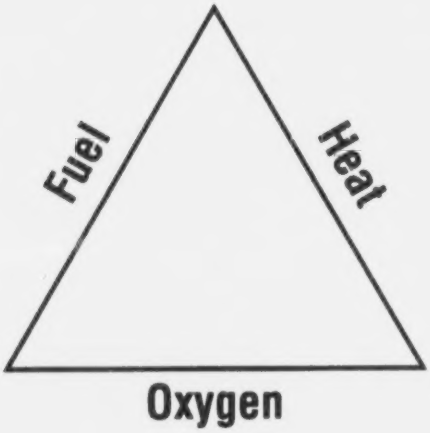
Caution: Never apply water to a flammable liquid or gas fire; such action can cause the fire to spread.

c. Class C—Fires that occur in or near electrical equipment such as motors, switch boards, and electrical wiring

d. Class D—Fires that occur with combustible metals such as magnesium, sodium, titanium, or phosphorus

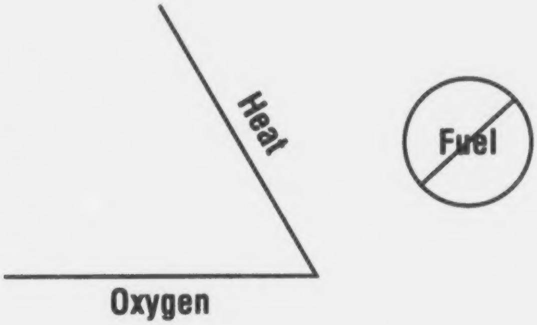
10. Components of the fire triangle

Note: The fire triangle represents the three elements necessary for fire. Combustion can occur only when all three elements are present at the same time and the triangle is complete. A fire will stop if any part of the fire triangle is missing.

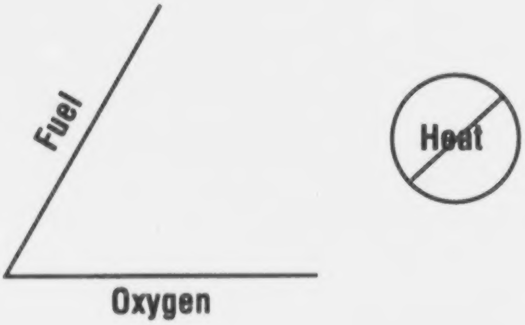


Information Sheet

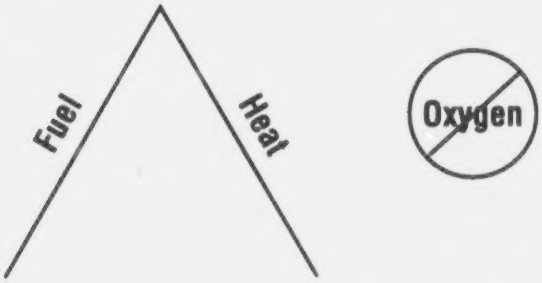
a. Fuel—Any combustible material



b. Heat—Enough to raise the fuel to its ignition temperature



c. Oxygen—Necessary to sustain combustion



Information Sheet

11. Types of fire extinguishers and classes of fires they are designed to extinguish

Type of Fire	Approved Type of Extinguisher				
	Pressurized Water	Carbon Dioxide	Multi-Purpose Dry Chemical	Halon Gas	Foam
Class A Fires ORDINARY COMBUSTIBLES • Wood • Paper • Cloth, etc.					
Class B Fires FLAMMABLE LIQUIDS, GREASE • Gasoline • Paints • Oils, etc.					
Class C Fires ELECTRICAL EQUIPMENT • Motors • Switches, etc.					
Class D Fires COMBUSTIBLE METALS • Magnesium • Phosphorus • Iron					

a. **Foam**—Spray foam above fire, allowing foam to fall lightly on the fire; use for class A or class B fires.

Caution: Do not spray a stream directly into the fire.

b. **Carbon dioxide (CO_2)**—Direct discharge as close to fire as possible, first at the edge of flames, then gradually forward and upward; use for class B or class C fires.

c. **Pressurized water**—Direct stream at base of fire; use for class A fires only.

d. **Dry chemical**—Direct at the base of the flames, then follow up by directing at remaining materials that are burning; use for all classes of fires.

e. **Halon**—Stand back several feet, hold container upright and direct at the base of fire, sweeping from side to side; use for class B or class C fires.

Note: Halon is a clean, pressurized, liquefied gas which does not leave a residue.

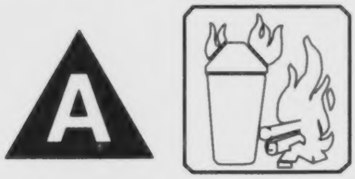
Caution: A high concentration of burned halon gas may be hazardous to your health.

Information Sheet

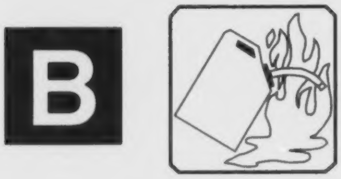
12. Fire extinguisher symbols and their meanings

Note: All portable fire extinguishers are labeled with picture and shape symbols. Each of the shape symbols contains the letter of the fire class for which the extinguisher is effective. Because speed is important when a fire is discovered, you should be able to glance at the symbols and know immediately whether the extinguisher is appropriate for the fire on hand.

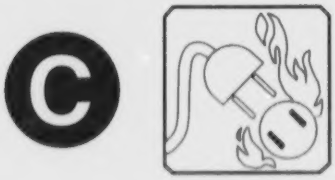
a. Class A—Green triangle



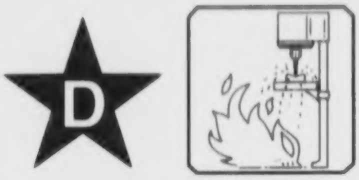
b. Class B—Red square



c. Class C—Blue circle



d. Class D—Yellow star



Information Sheet

13. Steps to be followed in case of an accident

a. Report all accidents and injuries to your supervisor.

b. Administer first aid if needed.

c. Investigate the accident to determine the cause and to determine ways to prevent the same accident from happening again.

d. Record the accident in writing.

14. Guidelines for lifting and carrying items safely

a. Before lifting

- Inspect the item to be lifted for jagged edges, splinters, grease, or other slippery surfaces.
- Wear gloves for protection.
- Wear lower back support.

  Example: Leather lower back support belt
- Plan your route before you lift.
- Clear any obstacles from your path.
- Assess the weight of the load.
- Get help for heavy loads.

b. Lifting

- Place your feet as close to the load as possible, one foot alongside the load and the other behind it.
- Bend your knees, keeping your back and neck straight and your chin tucked in.
- Grasp the load firmly with your fingers and hands.
- Draw your arms in close to your body.
- Stand slowly and lift smoothly, using your legs.

c. Carrying

- Hold items close to your body.
- Do not allow load to block your vision.
- Do not change your grip or twist your body to change direction.

  Note: Twisting the back while carrying a load (even a small one) can result in severe back injury.

Information Sheet

d. Setting down the load

- Bend your knees.
- Keep your back and neck straight and aligned.
- Place load carefully where you want it, taking care not to allow it to rest on your feet or fingers.

15. Purposes of a material safety data sheet (MSDS)

Note: The Federal Occupational Safety and Health Administration, administered by the U.S. Department of Labor, requires employers to keep material safety data sheets on all hazardous substances used by employees. Employees should be aware of their responsibilities and those of their employers concerning access to MSDS information and training.

a. To inform the user of the material's physical properties or fast-acting health effects that make it dangerous to handle.

b. To tell the user the level of protective gear needed.

c. To tell the user the first aid treatment necessary if exposed to the product or its hazards.

d. To tell the management and the user the preplanning needed for safely handling spills, fires, and day-to-day operations with the material.

e. To tell the user how to respond to accidents.

General Safety and First Aid
Unit 3-A

Student Supplement 1—A Systematic Look at First Aid

First aid can be defined as "immediate temporary care given the victim of an accident or suddenness or trauma until the services of a physician can be obtained."

The goal of first aid is to intervene actively to prevent further damage, to provide life support, and to begin effective treatment of the victim's condition, to minimize injury and prevent death. Although first aid is not a substitute for medical care, those trained in first aid are able to assess the nature and extent of an emergency and determine the best course of action to take until professional medical help arrives.

Scene Survey

First aid begins with a scene survey. Before approaching a victim, a survey of the area is necessary to determine if conditions surrounding the incident may place the victim and the rescuer in danger.

Primary Survey

Next, the primary survey will determine if lifesaving procedures must be immediately performed to save the victim's life. The primary survey involves checking the ABCs:

A: Is the AIRWAY open and the victim's neck stabilized?

The severity of spinal cord injuries has decreased 30–45 percent since awareness that the neck of an accident victim must be stabilized (supported or immobilized) before moving the victim.

B: Is the patient BREATHING?

C: Is the victim's blood CIRCULATING? Is there a pulse? Or is there active bleeding?

Lifesaving procedures, including cardiopulmonary resuscitation (CPR) may be needed to provide basic life support when a victim has no pulse and is not breathing. The Heimlich maneuver aids choking victims by forcing ejection of obstructing material from the windpipe.

Secondary Survey

The secondary survey is a total body examination, a pulse check, respiration count (breaths per minute), and observation of skin conditions. For electrical shock victims, this would be the time to search for both entrance and exit wounds.

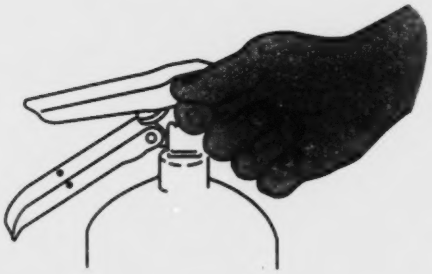
For severe medical problems, such as heart attack, stroke, or internal bleeding, the only outward sign of problems may be shock. Those in shock will have pale, cool and clammy skin; a rapid and weak pulse (over 100 beats per minute); more than 20 breaths per minute; weakness; and confused behavior. Treatment involves minimizing body heat loss, elevating the legs without disturbing the rest of the body, and getting help as quickly as possible.

General Safety and First Aid
Unit 3-A

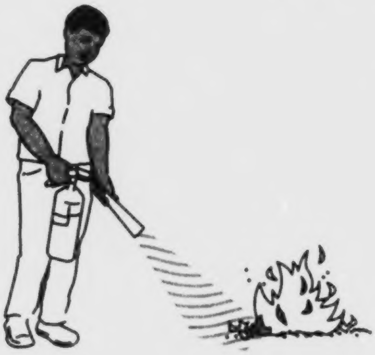
Student Supplement 2—The P-A-S-S Sequence for Using a Portable Fire Extinguisher

Remember the P-A-S-S sequence when using a portable fire extinguisher.

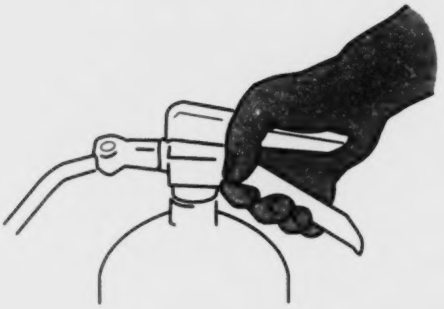
1. **P**ull the pin.



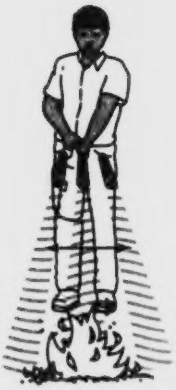
2. **A**im the nozzle at the base of the fire.



3. **S**queeze the handle.



4. **S**weep the nozzle.



General Safety and First Aid
Unit 3-A

Student Supplement 3—Guidelines for Interpreting Material Safety Data Sheets

Living in the modern world, you probably are aware that the use of chemicals offers convenience and progress at home and work. Naturally, you want to avoid dangerous overexposure to chemicals, especially on the job. Such overexposure is possible no matter where you work, even in an office or light industry.

Your company's hazard communications, or HazCom, program was created to protect your health and safety. Three important elements are at the heart of your HazCom program: warning labels on containers, training on the safe use and handling of chemicals, and material safety data sheets (MSDSs).

What is on an MSDS

MSDSs are printed pages that give you all the critical information you need about how to use, transport, and store chemicals in order to protect yourself, as well as what to do in case of emergencies and overexposure. Information on MSDSs includes:

- The chemical's name or names
- Name, address, and phone number of the manufacturer
- List of the chemical's ingredients
- Permissible exposure limits (PEL) or threshold limit value (TLV)
- What conditions or other substances will cause the chemical to catch fire, explode, melt, or turn into dangerous gases
- How the chemical usually looks and smells
- How to put out a fire involving the chemical
- What to do if the chemical spills or leaks
- How to prevent dangerous exposure
- Health hazards such as skin irritant or cancer-causing agent
- Symptoms of overexposure
- What to do if you are overexposed
- When the MSDS was prepared

The information for each chemical's MSDS is put together by the manufacturer or distributor for that chemical. The sheets often look different from each other, but they still provide the same information. The law requires your employer to keep MSDSs up to date and to send the MSDS to your doctor or designated representative if you request it.

Where the MSDS is kept

MSDSs must be readily accessible to employees—a posted sign may tell you where, and you can also find out by reading your company's written HazCom program. If you are not sure where to find MSDSs, your supervisor or your company's HazCom contact will make them available to you. It is the law.

Student Supplement 3

When to read an MSDS

You should always read the MSDS *before* you begin a job using a chemical. Even if you have used the chemical before, the manufacturer may have changed its formula, which may change the steps you should take to protect yourself. Taking proper precautions listed on the MSDS, such as wearing a respirator, can prevent serious long-term illnesses.

If you do not understand something on the MSDS, or have questions about your company's HazCom program, ask your supervisor or company contact. Your company knows that HazCom works best if you are fully informed and involved.

How to read an MSDS

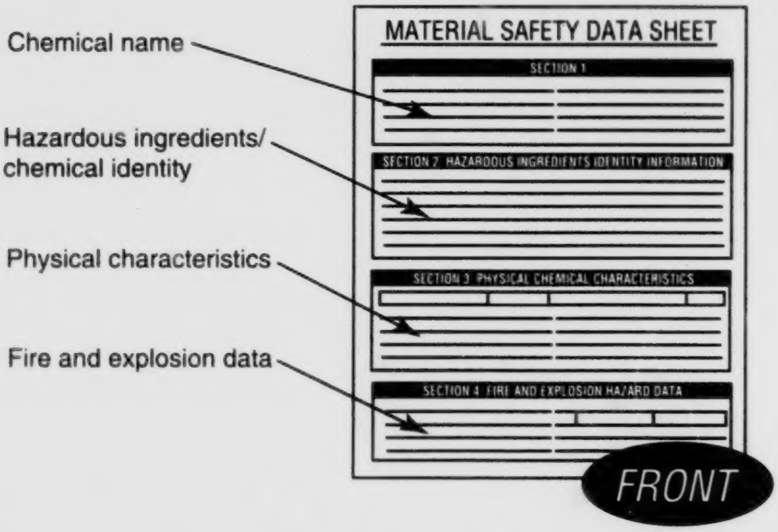
The material safety data sheet, or MSDS, is written information that can help protect you from overexposure to chemicals you find on the job. The MSDS is part of your company's hazard communications program. Each company can design its own MSDS form, and the sections may be in a different order. But the basic kinds of information on any MSDS will be the same.

Chemical name (see Figure 1). Lists the identity of the substance (the name on the label, date the MSDS was prepared, the name and address of the manufacturer, and usually a phone number for emergencies and more information).

Hazardous ingredients/chemical identity (see Figure 1). Includes names of substances in the chemical that might be dangerous, and lists safety exposure limits such as permissible exposure limit or PEL (set by OSHA) or the threshold limit value or TLV. Also lists common names for the chemical.

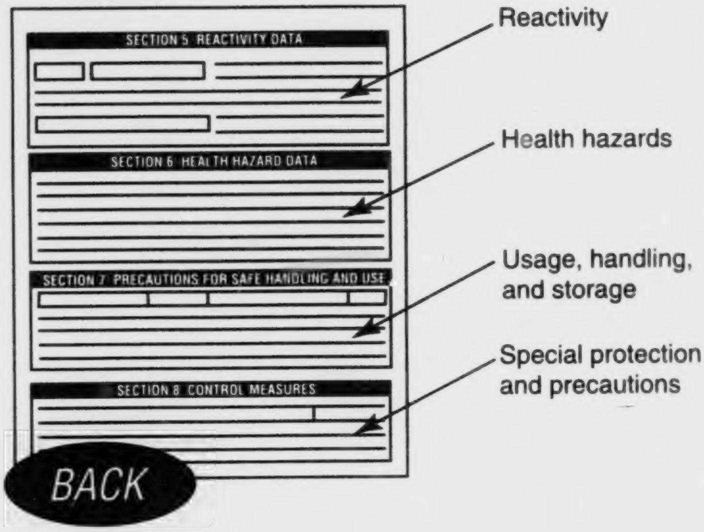
Physical characteristics (see Figure 1). Describes many physical qualities of the chemical, and lets you know what is usual or safe. For example, how the chemical looks and smells;

Figure 1


Chemical name
Hazardous ingredients/ chemical identity
Physical characteristics
Fire and explosion data
MATERIAL SAFETY DATA SHEET
SECTION 1
SECTION 2 HAZARDOUS INGREDIENTS/IDENTITY INFORMATION
SECTION 3 PHYSICAL/CHEMICAL CHARACTERISTICS
SECTION 4 FIRE AND EXPLOSION HAZARD DATA
FRONT

Student Supplement 3

Figure 2


SECTION 5 REACTIVITY DATA
SECTION 6 HEALTH HAZARD DATA
SECTION 7 PRECAUTIONS FOR SAFE HANDLING AND USE
SECTION 8 CONTROL MEASURES
Reactivity
Health hazards
Usage, handling, and storage
Special protection and precautions

BACK

boiling and melting temperatures (important in case a chemical might become a gas you could breathe); evaporation rate (known as percent volatile); how easily the chemical dissolves; and how heavy it is (this tells you if it will sink, float, or dissolve in water).

Fire and explosion data (see Figure 1). Tells you the lowest temperature at which the chemical could catch fire (flash point). Lets you know if it is flammable (catches fire below 100°F) or combustible (catches fire above 100°F). Lists the best way to put out a fire involving that chemical.

Reactivity (see Figure 2). Describes what happens if this chemical comes in contact with air, water, or other chemicals. Describes conditions (like heat) or materials (like water) that can cause the chemical to react by burning, exploding, or releasing dangerous vapors. The chemical is called "incompatible" or "unstable" with these conditions or substances.

Health hazards (see Figure 2). Lists ways the chemical might enter your body, like splashing on your skin or being breathed in as vapor, as well as possible symptoms of overexposure. Lets you know if overexposure might make existing medical conditions worse, and describes emergency first aid procedures.

Usage, handling, and storage (see Figure 2). Describes how to clean up an accidental spill, leak, or release, including special procedures. Tells you how to handle, store, and dispose of chemicals safely. Remember, if there is an accident, notify your supervisor immediately. Take care of it yourself only if you are trained to do so and are wearing the proper equipment.

Special protection and precautions (see Figure 2). Explains special personal protective equipment (PPE) and other equipment to use when working with the chemical, special procedures, extra health or safety information, signs that should be posted, and other information not covered in other sections.

Student Supplement 3

Terms and abbreviations used on MSDSs

The following terms and abbreviations will help you interpret material safety data sheets.

- **TLV**—Threshold limit value; a time-weighted average concentration *under which* most people can work consistently for 8 hours a day, day after day with no harmful effects
- **Ceiling**—Uppermost limit
- **ACGIH**—American Conference of Governmental Industrial Hygienists
- **OSHA**—Occupational Safety and Health Administration
- **PEL**—Permissible exposure limit; the maximum time-weighted concentration *at which* 95 percent of exposed, healthy adults suffer no adverse effects over a 40-hour week
- **ppm**—Parts per million
- **STEL**—Short-time exposure limit; a 15-minute, time-weighted average that should not be exceeded at any time during a workday. Exposures at STEL should not be longer than 15 minutes and should not be repeated more than four times a day with at least 60 minutes between exposures.
- **IDLH**—Immediately dangerous to life and health; material *at* or *above* this level poses an immediate hazard to life or produces immediate, irreversible, debilitating effects
- **LEL**—Lower explosive limit; below the flammability range (too lean to burn)
- **UEL**—Upper explosive limit; above the flammability range (too rich to burn)

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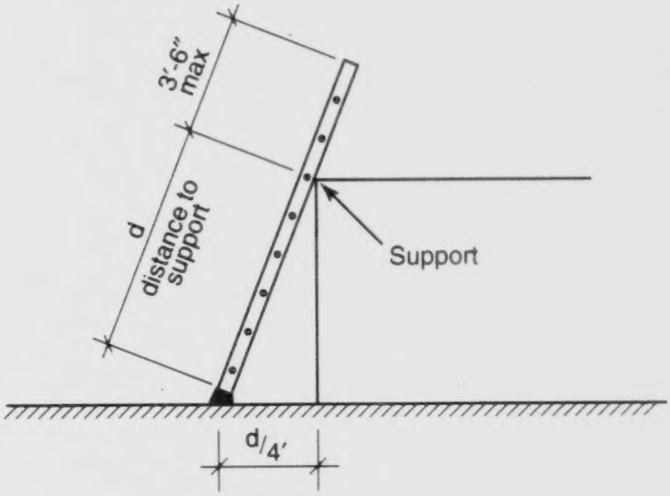
General Safety and First Aid
Unit 3-A

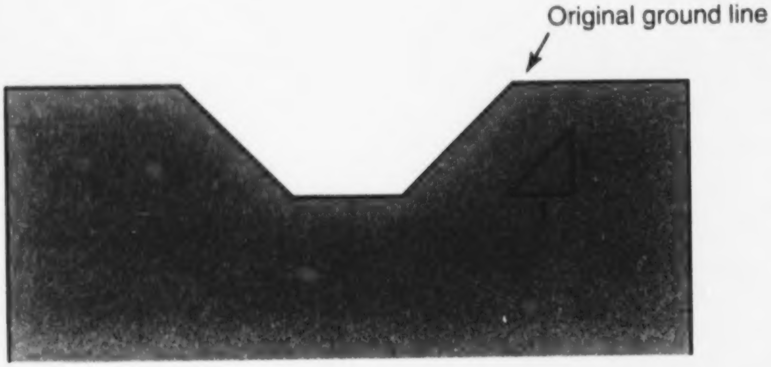
Student Supplement 4—Guidelines for Ladder Safety



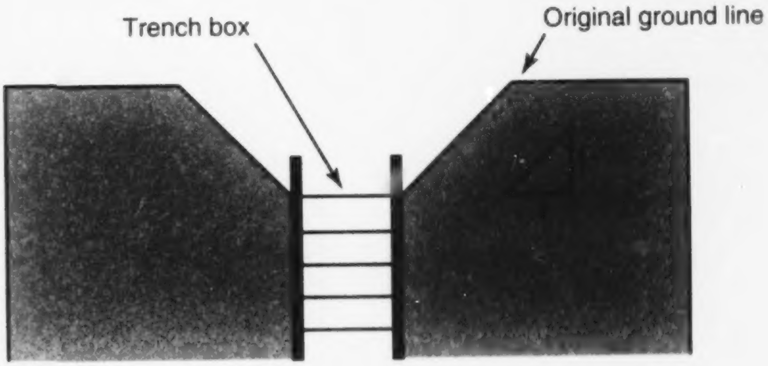
- Proper ladder placement prevents slipping and tilting.
- Distance between the bottom of the ladder and the supporting point should be approximately one fourth of the ladder length between supports.
- Always face ladder when ascending or descending.
- Never stand higher than the third rung from the top of the ladder.
- Ladders should have non-skid bases.

General Safety and First Aid
Unit 3-A

Student Supplement 5—Guidelines for Trench Safety



- Recommended slope for average soil is 1:1 (45°).
- Soil type should be checked for appropriate angles for slopes.



- A trench box is used in confined areas.
- Always follow OSHA regulations when digging a trench for pipe.

General Safety and First Aid
Unit 3-A

Assignment Sheet 1—Interpret a Material Safety Data Sheet

Name ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Directions are followed	______
• All answers are correct	______
• Assignment was neat and completed on time	______

Directions: Review the material in Objective 15 of the information sheet, and locate and study the information presented in Student Supplement 3, "Guidelines for Interpreting Material Safety Data Sheets."

Use the MSDS at the end of this assignment sheet to answer the following questions. Write your answers on the blanks provided below each item.

MSDS—Rectorseal No. 15

1. What is this product used for?

____

2. What are the hazardous ingredients in this product?

____

3. What does this product look like?

____

4. What is the flash point of this product?

____

5. What extinguishing agents should be used on fires created by this product?

____

6. What may happen to closed containers if heat builds up pressure?

____

7. Are any of the ingredients in this product suspected of causing cancer (carcinogenic)? Explain.

____

____

____

Assignment Sheet 1

8. What are the primary ways in which this product enters the body?

9. What are the symptoms of overexposure to this product?

10. What first aid measures should not be taken if this product is ingested and the victim is unconscious?

11. What conditions should be avoided when storing this product?

12. What materials should you avoid using with this product?

13. How should you dispose of this product?

14. Can this item be disposed of in a landfill?

15. What special protective measures should you take when using this product?

16. What special hygiene precautions should you take when using this product?

Assignment Sheet 1

Material Safety Data Sheet

RECTORSEAL -- RECTORSEAL NO. 15 - PIPE THREAD SEALANT
MATERIAL SAFETY DATA SHEET
FSC: 8030
NIIN: 00F006058
Manufacturer's CAGE: 2P988
Part No. Indicator: A
Part Number/Trade Name: RECTORSEAL NO. 15

General Information

Item Name: PIPE THREAD SEALANT
Company's Name: RECTORSEAL CORPORATION
Company's Street: 2830 PRODUCE ROW
Company's City: HOUSTON
Company's State: TX
Company's Zip Code: 77023-5822
Company's Emerg Ph #: (713) 928-6428
Company's Info Ph #: (713) 928-6428
Record No. For Safety Entry: 001
Tot Safety Entries This Stk#: 001
Date MSDS Prepared: 16OCT90
Safety Data Review Date: 14JAN88
Preparer's Company: RECTORSEAL CORPORATION
Preparer's St Or P. O. Box: 2830 PRODUCE ROW
Preparer's City: HOUSTON
Preparer's State: TX
Preparer's Zip Code: 77023-5822
MSDS Serial Number: BBTVM
Specification Number: MIL-T-5542

Ingredients/Identity Information

Proprietary: NO
Ingredient: NON-HAZARDOUS FOR INGREDIENTS
Ingredient Sequence Number: 01
Percent: 100%
NIOSH (RTECS) Number: 1000314NH

Physical/Chemical Characteristics

Appearance And Odor: BLACK PASTE/MILD ODOR.
Specific Gravity: 1.6
Solubility In Water: NEGLIGIBLE

Fire and Explosion Hazard Data

Flash Point: >400°F
Flash Point Method: TCC
Extinguishing Media: FOAM, DRY CHEMICAL, CO$_2$, OR WATER FOG
Special Fire Fighting Proc: WEAR SELF-CONTAINED BREATHING APPARATUS & FULL PROTECTIVE CLOTHING.
Unusual Fire And Expl Hazrds: HEAT MAY BUILD UP PRESSURE & RUPTURE CLOSED CONTAINERS.

Assignment Sheet 1

Reactivity Data

Stability: YES
Cond To Avoid (Stability): STORE >150F. HEAT, SPARKS, OPEN FLAMES
Materials To Avoid: STRONG OXIDIZING AGENTS
Hazardous Decomp Products: HYDROGEN CHLORIDE, CO, CO2
Hazardous Poly Occur: NO

Health Hazard Data

Route Of Entry - Inhalation: NO
Route Of Entry - Skin: YES
Route Of Entry - Ingestion: YES
Health Haz Acute And Chronic: SKIN: IRRITATION OR RASH. EYES: IRRITATION, WATERING. INGESTION: NAUSEA, VOMITING.
Carcinogenicity - NTP: NO
Carcinogenicity - IARC: NO
Carcinogenicity - OSHA: NO
Explanation Carcinogenicity: NONE
Signs/Symptoms Of Overexp: SKIN: IRRITATION OR RASH. EYES: IRRITATION, WATERING. INGESTION: NAUSEA & VOMITING.
Med Cond Aggravated By Exp: SKIN CONDITIONS
Emergency/First Aid Proc: SKIN: WASH W/SOAP & WATER. EYES: FLUSH W/ WATER. INGESTION: GIVE LARGE AMOUNTS OF WATER. INDUCE VOMITING. IF UNCONSCIOUS, DON'T GIVE ANYTHING BY MOUTH OR ATTEMPT TO INDUCE VOMITING. OBTAIN MEDICAL ATTENTION IN ALL CASES.

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: WIPE UP SPILLS TO PREVENT FOOTING HAZARD. FLUSHING INTO SEWERS, DRAINS, WATERWAYS & SOIL. WEAR PROTECTIVE CLOTHING DURING CLEANUP.
Waste Disposal Method: DISPOSE OF CLEANUP MATERIAL & LIQUID WASTE IN CONTROLLED INCINERATION FACILITIES IN ACCORDANCE W/ALL LOCAL, STATE & FEDERAL REGULATIONS.
Precautions-Handling/Storing: KEEP CONTAINER CLOSED & UPRIGHT WHEN NOT IN USE. DON'T STORE NEAR HEAT, SPARKS, OR OPEN FLAMES. DON'T STORE >150°F. AVOID CONTACT W/SKIN & CLOTHING.
Other Precautions: EMPTY CONTAINERS MAY CONTAIN RESIDUES/VAPORS; TREAT AS IF FULL & OBSERVE ALL PRODUCT PRECAUTIONS. DON'T REUSE EMPTY CONTAINERS. KEEP OUT OF REACH OF CHILDREN. WASH EXPOSED AREAS THOROUGHLY BEFORE EATING, DRINKING, SMOKING/LEAVING WORK AREA.

Control Measures

Respiratory Protection: NORMALLY NONE REQUIRED
Ventilation: LOCAL EXHAUST/MECHANICAL (GENERAL): ACCEPTABLE.
Protective Gloves: NON-PERMEABLE
Eye Protection: GOGGLES
Other Protective Equipment: COVERALLS
Work Hygienic Practices: LAUNDER/REMOVE CONTAMINATED CLOTHING BEFORE REUSE.

Assignment Sheet 1

```
================================================================================
                    Disposal Data
================================================================================
Disposal Data Review Date: 90044
Rec # For This Disp Entry: 01
Tot Disp Entries Per NSN: 001
Landfill Ban Item: YES
Disposal Supplemental Data: MSDS DATE: 06/86. IN CASE OF ACCIDENTAL
EXPOSURE OR DISCHARGE, CONSULT HEALTH AND SAFETY FILE FOR PRECAUTIONS.
1st EPA Haz Wst Name New: NOT REGULATED
1st EPA Haz Wst Char New: NOT REGULATED BY RCRA
1st EPA Acute Hazard New: NO
================================================================================
                    Label Data
================================================================================
Label Required: YES
Label Status: G
Common Name: RECTORSEAL NO. 15
Special Hazard Precautions: SKIN: IRRITATION OR RASH. EYES: IRRITATION,
IRRITATION, WATERING. INGESTION: NAUSEA & VOMITING.
Label Name: RECTORSEAL CORPORATION
Label Street: 2830 PRODUCE ROW
Label City: HOUSTON
Label State: TX
Label Zip Code: 77023-5822
Label Emergency Number: (713) 928-6428
================================================================================
```

General Safety and First Aid
Unit 3-A

Assignment Sheet 2—Analyze Problems Related to Shop Safety and First Aid

Name ______________________________ Overall Rating ____________

Evaluation Criteria	Rating
• Directions are followed	______
• All answers are correct	______
• Assignment was neat and completed on time	______

Part A

Directions: Given the accidents below, state the general shop safety and first aid rule(s) that would have prevented the accident from occurring.

Note: More than one rule may apply to some situations.

1. A worker is removing a sheet metal panel and cuts the palm of the hand to the bone.

   ____

   ____

2. A worker slips and falls on a small piece of copper tubing which was left in a walkway.

   ____

   ____

3. One worker is using gasoline as a cleaning solvent when another worker lights a torch nearby; both are badly burned.

   ____

   ____

4. A worker tosses a screwdriver toward the tool box. The screwdriver hits the floor and bounces, hitting another worker in the eye.

   ____

   ____

5. A worker detects a fire in some "hot" electrical equipment and begins to douse the fire with buckets of water. The worker is electrocuted.

   ____

   ____

Assignment Sheet 2

Part B

Directions: Answer the following questions in the spaces provided.

1. While working in the shop you hear a crash and run towards the noise. You find a co-worker lying on the floor with a ladder on top of him. What steps should you take?

   ____

   ____

2. A worker is using a welding torch. The torch slips and the flame burns his bare hand. The skin appears to be white and leathery, but does not seem to be painful. What type of burn is this and how should it be treated? How could the accident have been prevented?

   ____

   ____

General Safety and First Aid
Unit 3-A

Job Sheet 1—Operate a Fire Extinguisher

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Extinguisher was carried properly	________
• User was within stream reach of fire	________
• P-A-S-S sequence was followed	________
• Fire was completely extinguished	________

Introduction: Using a portable fire extinguisher properly requires more than simple manipulation. You must always size up the fire and decide whether it can be extinguished with an extinguisher. If the fire is too large or too smoky, call the fire department. If the fire is small enough to be extinguished with an extinguisher, always fight it with your back to a means of escape.

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Portable fire extinguisher suitable for a Class A fire
- Small class A fire in clear, safe area
- Charged hose (hose hooked up to a water source and with water in the hose) or another secondary means of extinguishment for backup

Caution: This procedure should only be performed outdoors on a windless day and only under the direct supervision of your instructor.

B. Procedure

☐ 1. Pick up the fire extinguisher by its handle.

Note: All modern fire extinguishers are designed to be used in an **upright** position.

☐ 2. Read the fire extinguisher label to determine proper stream reach.

Note: *Stream reach* is the distance the extinguishing agent is propelled. Stream reach varies with extinguisher, and may range from 3 to over 20 feet. Normally, the smaller the extinguisher, the shorter the stream reach.

☐ 3. Walk—do not run—to within stream reach of the fire.

☐ 4. **Pull** the pin at the top of the extinguisher that keeps the handle from being pressed.

Note: Pulling the pin automatically breaks the plastic or thin wire inspection band.

Job Sheet 1

☐ 5. **Aim** the nozzle toward the fire, first releasing it from its clip if applicable.

☐ 6. **Squeeze** the discharge handle (above the carrying handle) to release the extinguishing agent.

Note: The discharge handle can be released at any time to stop the discharge.

☐ 7. **Sweep** the nozzle back and forth at the base of the flames.

☐ 8. After the fire appears to be out, probe for remaining hot spots.

☐ 9. Make sure the fire is out by extinguishing any hot spots.

Evaluator's Comments: ____________________

____

____

General Safety and First Aid
Unit 3-A

Job Sheet 2—Lift a Heavy Object Properly

Name ______________________________ Attempt Number ______________

Date ______________________________ Overall Rating ______________

Evaluation Criteria	**Rating**
• Support belt was worn	________
• Load was lifted safely	________
• Load was carried and set down safely	________

Introduction: The number-one worker injury in America today is back strain or injury. Most of these injuries come from trying to lift an object that is too heavy or from lifting an object improperly. It is very important, therefore, that you learn to assess the weight of a load to be lifted, and either get help to lift the load or lift the load properly, using your leg muscles, not your back.

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Large, heavy box
- Gloves
- Lower-back support belt

B. Procedure

☐ 1. Put on gloves and lower-back support belt.

☐ 2. Size up the load.

☐ 3. Place your feet close to the object and 8 to 12 inches apart for good balance.

☐ 4. Bend your knees to a degree that is comfortable.

☐ 5. Grip the box firmly with both hands.

☐ 6. Keeping your back straight and using your leg muscles, lift the box to waist height and hold close to your body.

Caution: Do not make any turning or twisting motions until the lift is complete.

☐ 7. Turn by changing foot position, making sure that your path is clear.

Job Sheet 2

☐ 8. Carry the box to the new location, using a normal walking gait and keeping your view unobstructed.

☐ 9. Reverse the lifting procedure to set the box down, taking care to bend your knees, keep your back straight, and avoid setting the box on your fingers or feet.

Evaluator's Comments: ______________________________

____

____

Hand Tools
Unit 1-B

Objective Sheet

Unit Objective

After completing this unit, the student should be able to identify hand tools used in the plumbing trade and demonstrate their proper use and care. The student should demonstrate these competencies by completing the assignment sheets and job sheets and by scoring a minimum of 85 percent on the written test.

Note: The student must score 100 percent on the safety section of the test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to hand tools with the correct definitions.
2. Identify basic hand tools used in the plumbing trade.
3. Complete statements concerning proper use and care of hand tools.
4. List safety precautions for handling and storing hand tools.
5. Identify rules used for measuring.
6. Select true statements concerning guidelines for the use and care of rules and steel tapes.
7. Read a rule/tape measure. (Assignment Sheet 1)
8. Measure lines to the nearest quarter, eighth, and sixteenth of an inch. (Assignment Sheet 2)
9. Use hand tools to inspect/replace a washer on a globe valve. (Job Sheet 1)
10. Measure and mark a predetermined length of pipe. (Job Sheet 2)
11. Use hand tools to cut a length of steel pipe. (Job Sheet 3)
12. Use hand tools to ream steel pipe. (Job Sheet 4)
13. Use hand tools to cut pipe threads. (Job Sheet 5)
14. Set up and use a hacksaw to cut a length of PVC pipe. (Job Sheet 6)

Hand Tools
Unit 1-B

Information Sheet

1. **Terms and definitions**

   a. **Hand tool**—Tool used for common plumbing jobs, usually owned by a plumber

   Note: The majority of work in simple plumbing jobs is done with hand tools.

   b. **Male/female**—Designates joints of pipe in reference to the fitting; female receives the male pipe

   c. **Pipe thread**—A special thread designed for piping systems; does not fit objects with machine threads

   d. **Pipe wrenches**—Tools used to turn threaded pipes and fittings, made in a variety of sizes and shapes

   e. **Plumber's tool box**—Personalized tool kit containing the basic hand tools

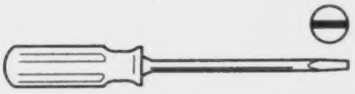
   f. **Safety**—The state or condition of being free from danger, risk, or injury

   g. **Specialized tool**—Tool designed for a particular use, usually provided by the employer

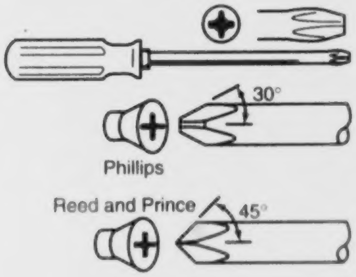
   h. **Threading**—Method of developing spiral cuts on pipe in order to facilitate joining

2. **Basic hand tools used in the plumbing trade**

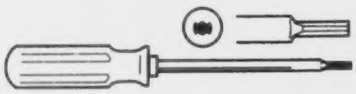
   a. **Screwdrivers**



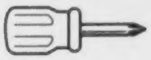
- Standard slot



- Phillips



- Clutch head

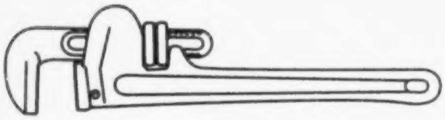


- Stubby

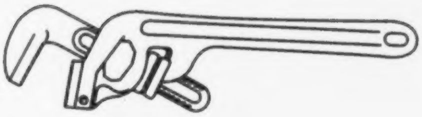
Information Sheet

- Offset

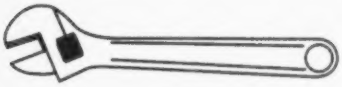
b. **Wrenches**



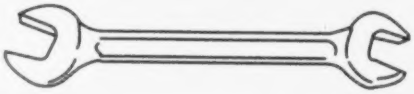
- Straight pipe wrench



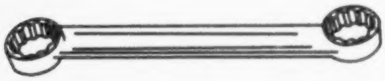
- 14″ offset pipe wrench



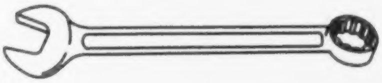
- 8″ adjustable wrench



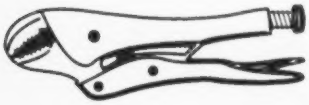
- Open end wrench



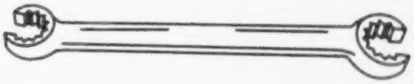
- Box end



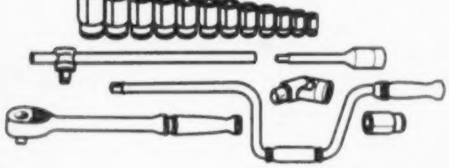
- Combination



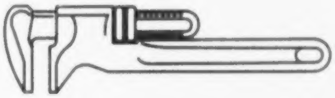
- 8″ plier wrench (vise grips)



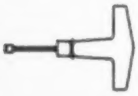
- Flare nut wrench



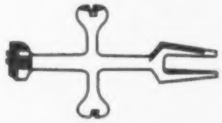
- Socket wrenches and ratchet



- 12″ spud wrench

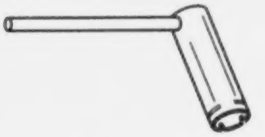


- No-hub torque wrench

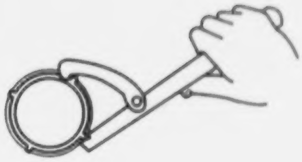


- Plug wrench

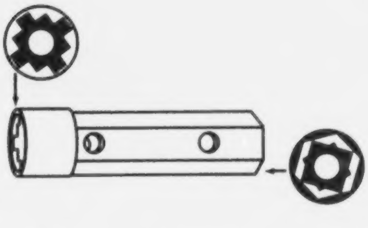
Information Sheet



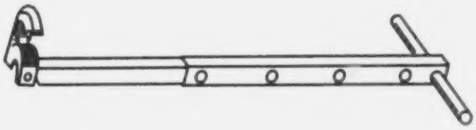
- Sink strainer wrench



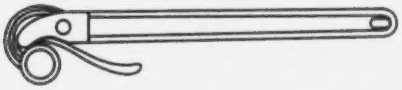
- Strainer locknut wrench



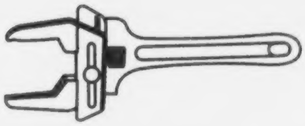
- Closet seat wrench



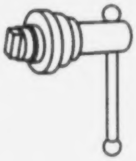
- Basin wrench



- Strap wrench

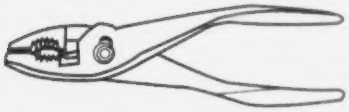


- All-purpose wrench

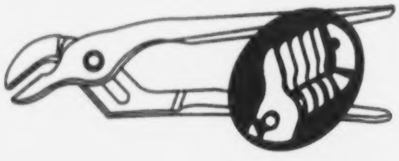


- Internal wrench

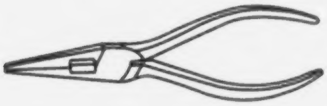
c. **Pliers**



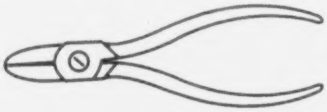
- Slip joint



- Slip groove

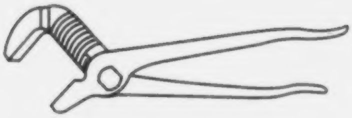


- Needle nose

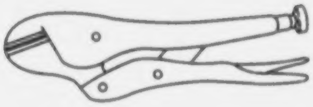


- Diagonal cutters

Information Sheet

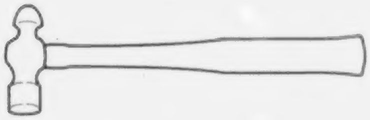


- Adjustable

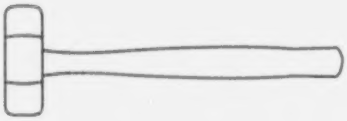


- Pinch-off

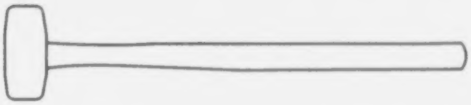
d. **Hammers and nail pullers**



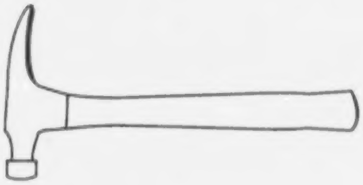
- Ball peen



- Soft face



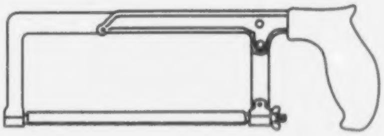
- Long-handle sledge



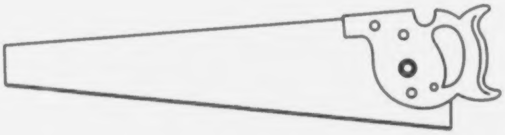
- Straight claw

- Nail puller

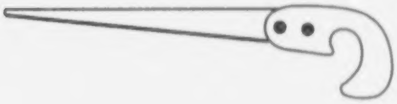
e. **Saws**



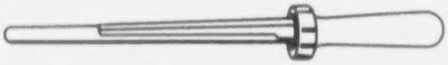
- Hacksaw



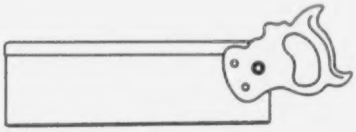
- Handsaw



- Compass or keyhole saw



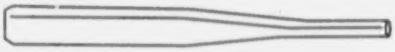
- Jabsaw



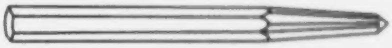
- Miter saw

Information Sheet

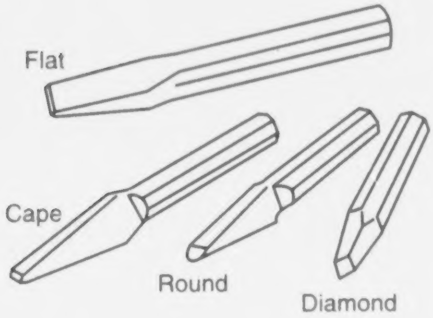
f. **Punches, chisels, and bars**



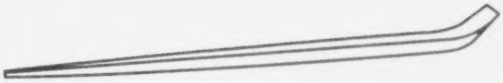
- Pin punch



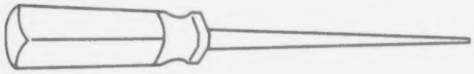
- Center punch



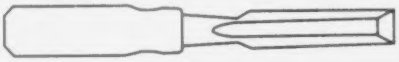
- Cold chisel



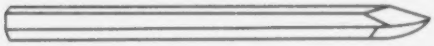
- Pry bar



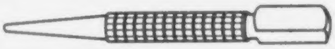
- Scratch awl



- Wood chisel

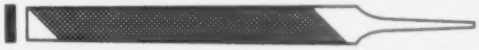


- Bullnose chisel

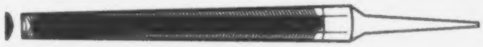


- Nail set

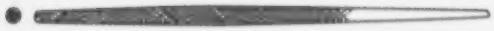
g. **Files**



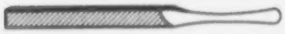
- Flat



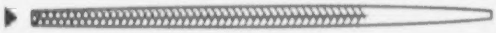
- Half round



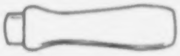
- Round (rattail)



- Point



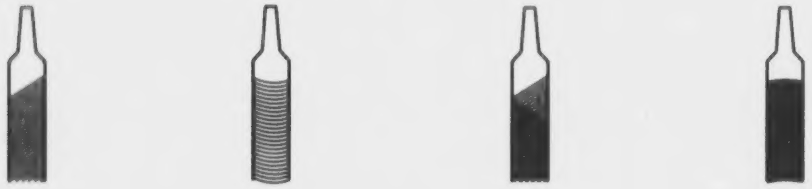
- Triangular



- Handle

Information Sheet

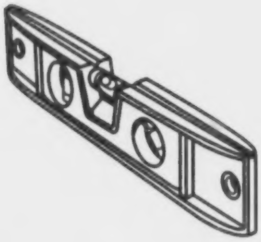
Types of File Teeth



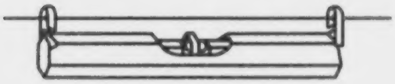
Single Cut Curved Tooth Double Cut Rasp Cut

h. **Levels, plumb bob, and chalk line**

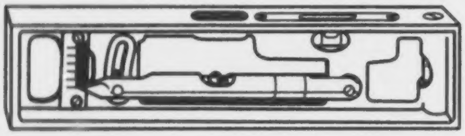
- Carpenter's level



- Torpedo level

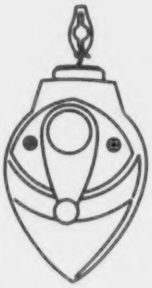


- Line level



- Plumber's level

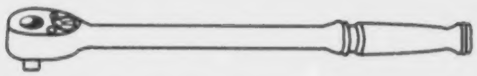
- Plumb bob



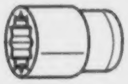
- Chalk line

Information Sheet

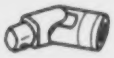
i. Socket sets



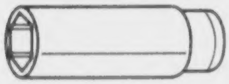
- Ratchet handle



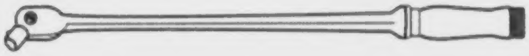
- Socket



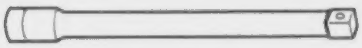
- Universal joint



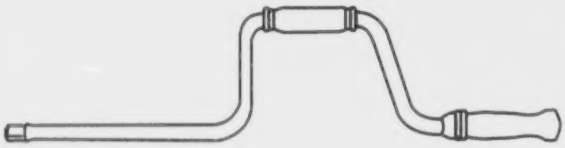
- Deep socket



- Hinge handle (break-over)

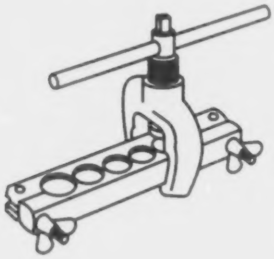


- Extension

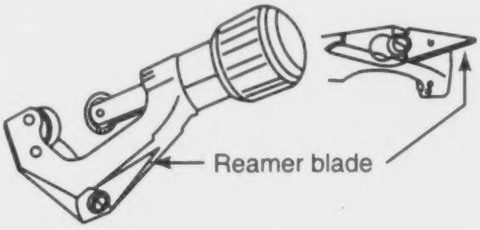


- Speed handle

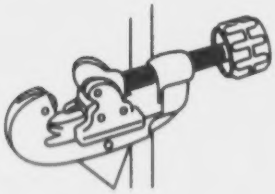
j. Tubing tools



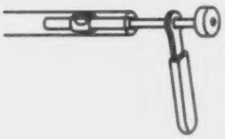
- Flaring tool



- Tubing reamer

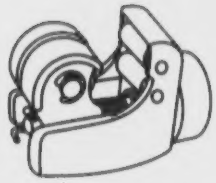


- Tubing cutter

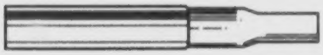


- Internal cutter

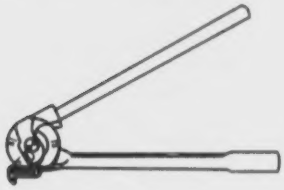
Information Sheet



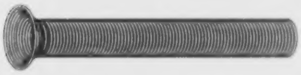
- Close tubing cutter



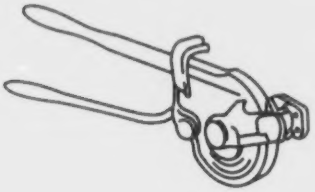
- Swage punch



- Lever-type bender

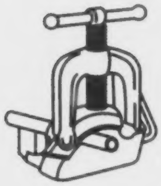


- Spring bender

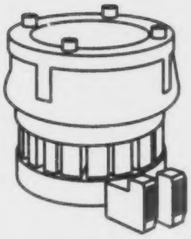


- Geared ratchet-type bender

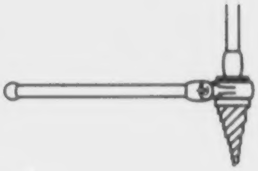
k. **Iron pipe tools**



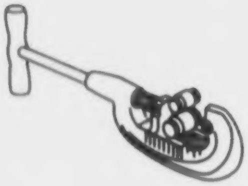
- Pipe vise



- Dies and die head



- Pipe reamer

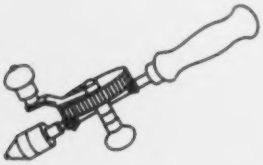


- Pipe cutter

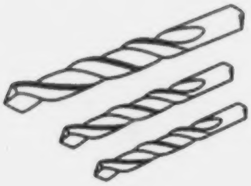
Information Sheet

l. **Drilling and boring tools**

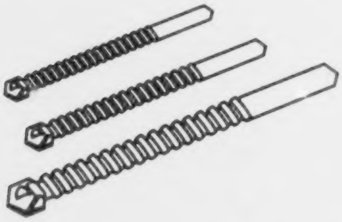
- Drilling tools



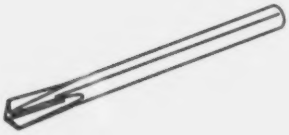
— Hand drilling machine



— High speed drill bits

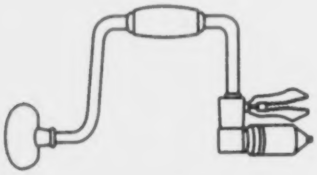


— Masonry drill bits

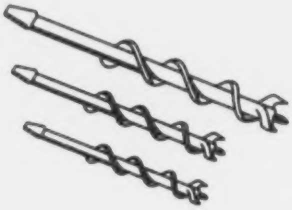


— Star drill bit

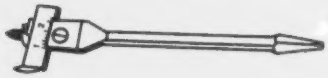
- Boring tools



— Ratchet brace

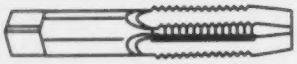


— Wood bits ($^1/_2$″, $^3/_4$″, and 1″)

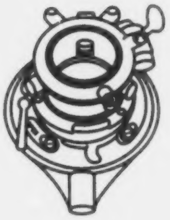


— Expansive wood bit ($^3/_4$″)

m. **Threading tools**

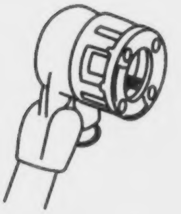


- Tap

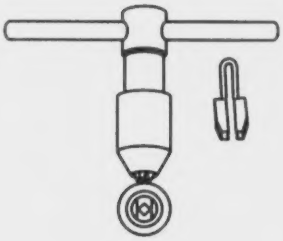


- Stock and dies

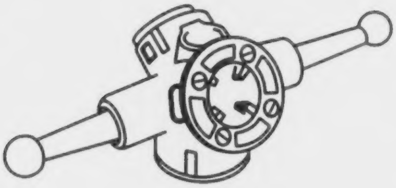
Information Sheet



- Die stock

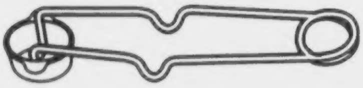


- T-handle tap wrench



- Three-way pipe die

n. **Copper tubing tools**



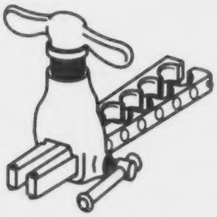
- Striker

- Flux brush

- Clean towel (wiping cloth)

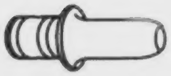
- Sand cloth

- Pocket knife

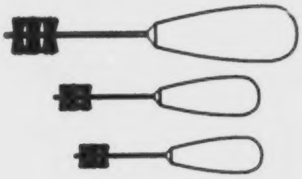


- Yoke and screw flaring tool

Information Sheet

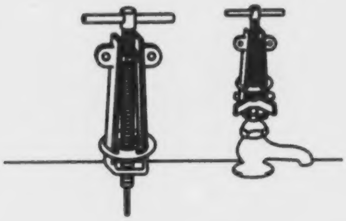


- Hammer flaring tool

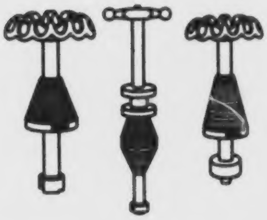


- Copper fitting brushes

o. **Faucet and toilet tank repair tools**

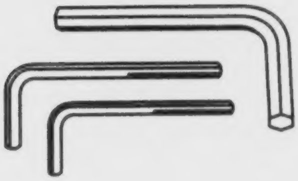


- Faucet handle puller

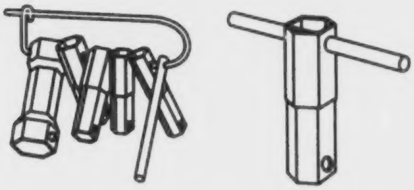


- Valve seat dresser

- Valve seat wrench



- Hex wrench (Allen wrench)



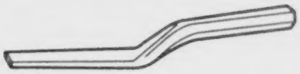
- Plumber's socket wrench

- Tubing tap and die set

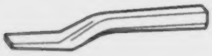
- Sink spray wrench

Information Sheet

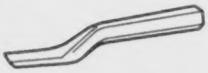
p. **Caulking tools**



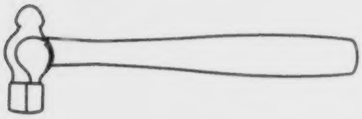
- Yarning iron



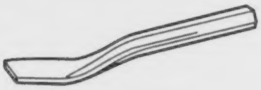
- Inside caulking iron



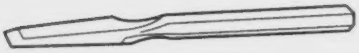
- Outside caulking iron



- Caulking hammer



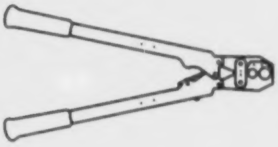
- Packing iron



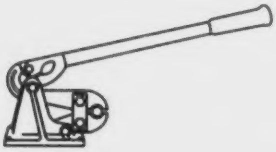
- Cut-off chisel

q. **Polybutylene tools**

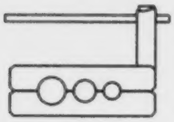
- Crimping tools



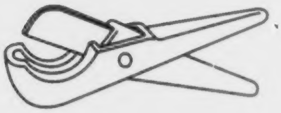
  — Handheld



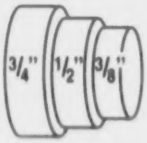
  — Bench mounted



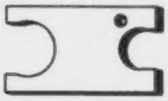
  — Universal



- Polybutylene tubing cutter



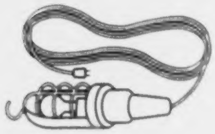
- Tool set gauge



- Crimp calipers

Information Sheet

r. **Accessory hand tools**

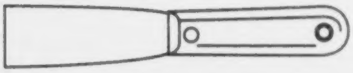


- Drop light

- Straight snips

- Nut driver

- Pipe tap



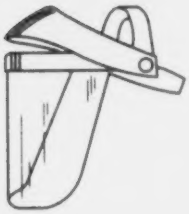
- Putty knife

- Cutting oil or lubricating oil

s. **Eye protection**

- Safety glasses

- Goggles



- Face shield

Information Sheet

3. Proper use and care of hand tools

Note: Plumbers usually purchase their own tools, and therefore, must develop a special responsibility towards their care.

a. **Screwdrivers**

1) Use

- Phillips head screwdriver—Used in fixture installation since most screws on fixture trim have phillips heads

  Note: Use proper size to prevent rounding out screw slots.

- Standard slot screwdriver—Used for tightening or loosening bolts and screws with a slot type head
- Clutch head screwdriver—Used for tightening or loosening a clutch head bolt or screw

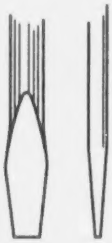
  Note: The blade must fit the screw slot in order to function properly.

- Offset screwdriver—Used for working in extremely close places

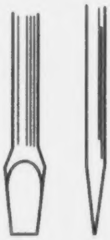
2) Care

- Grind flat tip square.

Ground right



Ground wrong



- Discard worn phillips tips.
- Do not hammer on screwdrivers.

b. **Wrenches**

1) Use

- Small pipe wrench—Handy for small pipe and round objects, especially in tight places
- Offset pipe wrench—Used for working in corners and other tight places
- Adjustable wrench—Used because it can replace several different sizes of open end wrenches

Information Sheet

- Open end wrench—Used because it is not likely to slip off an object when being used
- Plier wrench (vise grip)—Has a locking lever to prevent slipping and is used when an especially tight grip is needed

  Note: A plier wrench should not be used where scratches from jaw teeth create an unsightly installation.

- Flare nut wrench—Used to tighten or loosen a flare nut because its open ends can easily slip over the tubing
- Socket wrench—Used when working with nuts and bolts that adjustable or open end wrenches cannot reach
- Spud wrench—Used primarily to hold slip nuts which have flat surfaces and/or require care in avoiding scratches
- Plug wrench—Used to tighten lavatory and bath drains
- No-hub torque wrench—Used to tighten stainless steel clamps on no-hub pipe connections
- Sink strainer wrench—Used to tighten the sink strainer
- Strainer locknut wrench—Used to tighten the large locknut beneath the sink strainer
- Plumber's socket wrench—Used to remove the bonnet from tub and shower faucets in order to repair or replace the valve stem

  Note: Neatly trim tile from around the valve to allow access for socket wrench.

  Caution: Always wear safety glasses.

- Basin wrench—Used to loosen and/or tighten locknuts and water supply connecting nuts on sink and lavatory faucets
- Strap wrench—Used instead of a pipe wrench when scratches and other pipe wrench damage would affect the appearance of the installation

  Note: Keep strap dry and free from oil.

- Internal wrench—Used for installing close nipples without damage to threads

2) Care

- Keep wrenches clean and dry and lightly oiled.
- Turn adjustable wrenches in proper direction.
- Discard wrenches with damaged or "spread" jaws.
- Do not hammer with wrenches.

Information Sheet

c. Pliers

1) Use

- Slip joint pliers—Used for holding or turning a part where marring the surface is not a problem
- Slip groove pliers—Used for the same purpose as slip joint pliers, but the jaws will generally open wider and the handles provide more leverage
- Needle nose (long nose) pliers—Used for retrieving loose parts in a faucet and repairing drop lights and extension cords
- Diagonal cutters—Used for cutting wire, solder, and metal straps

  Note: This tool should not be used for tin snips.

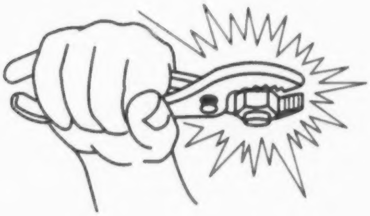
- Adjustable pliers—Used for turning difficult to open locknuts, bath and shower drains, and many other plumbing fixtures

  Note: Avoid scratching surfaces where appearance is important.

- Pinch off pliers—Used for holding objects or cutting through very thin objects

2) Care

- Have handles insulated when working on electrical circuits.
- Do not use pliers in place of wrench.



d. Hammers and nail pullers

1) Use

- Ball peen hammer—Used for hammering on metal tools such as punches and chisels, and are ideal for caulking cast iron joints
- Soft face hammer—Used for hammering or driving materials that a steel face hammer would mar or break

  Note: Soft face hammer faces are made of plastic, rubber, rawhide, copper, lead, or wood.

- Sledge hammer—Heavy, long-handled hammers used for breaking and pounding objects

Information Sheet

- Claw hammer—Used for driving and pulling nails to prepare wood frame structures for piping installations, and to move or alter existing framing members

  Note: Never use a hammer with a worn face.

- Nail puller—Used to remove nails when moving studs, flooring, and other wood structure when destructive methods must be avoided

2) Care

- Use the proper type hammer for the job.
- Keep handle tight.
- Keep hammers dry and clean.

e. **Saws**

1) Use

- Hacksaw—Used for cutting metals

  Caution: A hacksaw is not recommended for cutting pipe and tubing; use tubing cutters and pipe cutters.

- Handsaw—Used for notching access holes and for cutting plastic pipe
- Compass or keyhole saw—Used for cutting curved shapes in close quarters
- Jabsaw—Used for cutting metal in small, tight areas
- Miter saw—Used with a miter box to ensure a square, accurate cut on plastic pipe

  Note: This is also known as a backsaw.

2) Care

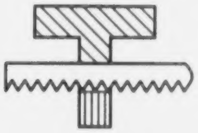
- Keep saw blades dry and lightly oiled.
- Keep a protective guard on the cutting edge when the saw is not being used.
- Most saws cut on the forward stroke; release downward pressure on the return (or back) stroke.

Information Sheet

- Number of teeth per inch (points) indicates how fine a cut the saw will make.

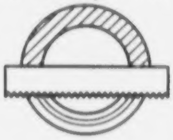
  Note: At least two teeth should be on the work piece at all times while cutting.

24 Teeth per inch



For angle iron, heavy pipe, brass, copper

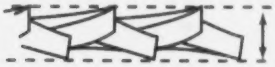
32 Teeth per inch



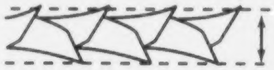
For thin tubing

- Type of saw tooth and set of tooth is important to the cut being made.

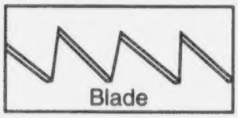
Top view of rip teeth



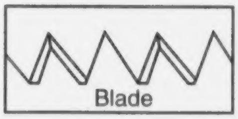
Top view of crosscut teeth



Teeth of rip saw



Teeth of crosscut saw



- A used blade makes a more narrow cut than a new blade; therefore, do not use a new blade in an old cut.

f. **Punches, chisels, and bars**

1) Use

- Pin punch—Used for driving both straight and tapered pins in or out of hubs and shafts and for dislodging corroded parts
- Center punch—Used for making indentations in metal for starting a drill
- Cold chisel—Used to cut cast iron pipe

  Note: They come in several shapes: flat, cape, diamond point, and round nose.

- Flat chisel—Used for cutting off bolt heads or splitting nuts

  Note: The flat chisel is the most useful chisel for general purposes.

- Wood chisel—Used to trim openings and to cut notches and holes in wood structures for pipes
- Bullnose chisel—Used for chipping or breaking holes in concrete

Information Sheet

- Pry bar—Used for jobs that require prying an object into alignment
- Scratch awl—Used for scratching a line on metal, making screw holes in sheet metal, and for aligning screw holes
- Nail sets—Used in various ways such as chipping glazed bathroom tile for screw holes when hanging lavatories

2) Care

- Keep cutting edges and points sharp and the head clean and tapered.

  Note: Do not overheat chisel points.

- Keep head ground to prevent mushrooming.
- Wood chisels should be ground to a 25° angle and must be periodically honed and oiled in order to maintain a sharp edge.
- Chisels and hammers should be held loosely but firmly in order to bounce the chisel as it is struck.

g. **Files**

1) Use

- Flat file—Used for smoothing metal surfaces

  Note: This file is a double-cut file.

- Half round file—Used for fitting rounded surfaces on metals
- Round file—Used for enlarging holes in metal
- Point file—Used for filing contact points
- Triangular file—Used for cleaning up damaged threads
- Rasp—Wood file used to enlarge pipe holes
- Wooden handle—Used on one end of the file to prevent tip from gouging the worker's hand

  Note: Always use a handle on a file.

2) Care

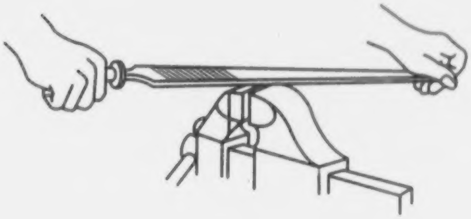
- Keep files on a wall rack.

  Note: They will become dull if stacked in a drawer.

- Use a file card or brush to clean a file.
- File using a flat, not "rocking" motion.

Information Sheet

Note: Use the whole length of the file.



- Use long, slow strokes when filing; the harder the metal is, the slower the stroke should be.
- Release pressure on the back stroke when using a file as the cutting edges can be worn down by applying too much pressure.

  Note: Files, like handsaws, cut only on the forward stroke.
- Do not pry or hammer with a file.

  Note: They are very brittle and will break.

h. **Levels, plumb bob, and chalk line**

1) Use

- Level—Used to determine correct pitch of drainage pipes
- Plumb bob and line—Used to locate the center of vertical runs and to transfer the point from one floor level to another

  Note: The point of the plumb bob must hang directly below the string in a vertical plane. Rounded or bent points can cause inaccurate measurements.
- Chalk line (chalk box) is most commonly used for laying out wall locations for piping installations.

  Note: Different colored chalk can be used for specific purposes.

2) Care

- Handle levels cautiously as vials (tubes) can be broken easily, making the level useless.
- Occasionally run a flat file over the surface of a metal level to remove burrs.

  Note: If properly treated, burrs will not develop.
- Keep wooden levels dry to avoid splinters and warping.
- Keep surfaces on torpedo levels free of burrs to allow accurate readings.

Information Sheet

- Check condition of plumb bob and line and replace if needed.

  Note: Rounded or bent points on plumb bob can cause inaccurate measurements. The line must be of good quality to avoid breakage or excessive wear.

- Use the following steps to establish an accurate measurement:
  - Stretch the line tightly.
  - Do not allow the line to touch any object between the two points.
  - Do not allow the plumb bob to swing when the measurement is taken.
  - To determine an accurate location, you can rest the plumb bob on the surface, lift it slightly, and then rest it on the surface again.
- Keep chalk line (chalk box) dry.
- The chalk box must be refilled periodically.

i. **Socket sets**

Note: Socket sets are made in $^1/_4$"-drive and $^1/_2$"-drive for light and heavy jobs.

1) Use

- Ratchet—Drive handle that sockets fit into and permits tightening and loosening with very little swinging room
- Socket—Used for tightening or loosening a hex head bolt or nut and is used in conjunction with ratchet
- Deep socket—Has an extended wall for reaching recessed bolts and nuts or nuts that have the bolt extending through them so far that standard socket will not fit over them
- Hinge handle—Used with sockets when more force is needed to break loose or tighten a nut or bolt
- Extension—Rod that fits between the socket and drive handle to extend the socket into hard-to-reach places
- Speed handle—Used with sockets to quickly tighten or loosen bolts and nuts that are easy to reach
- Universal joint—Fits between the drive handle and the socket, and bends in any direction enabling the socket to get to hard-to-reach nuts or bolts

2) Care

- Do not use an extension pipe or cheater bar on the handle of a ratchet as too much force will strip the gears in the ratcheting mechanism.
- Do not use a handle and extension pipe with thin-wall sockets as thin-wall sockets will break.

Information Sheet

j. **Tubing tools**

1) Use

- Flaring tool—Used for forcing a 45° cone into the end of a piece of tubing being held by a flaring block, which creates a flare on the tubing
- Flaring block—Used to hold the tubing by tightening it onto the tubing and rotating it at the same time
- Tubing cutter—Used to cut the tubing by tightening it onto the tubing and rotating it at the same time

  Note: Cutter is available in small, medium, and large sizes.
- Tubing reamer—Used to remove the burr from inside of tubing after it has been cut

  Note: This is usually attached to the tubing cutter.
- Swage punch—Used to enlarge the end of a tube so that another tube of the same size may be placed in it and soldered
- Lever-type bender—Tubing is held securely against the bender and the arm is slid over the tubing, forcing the tubing into the rounded end of the bender
- Spring bender—Coil spring which is placed on the outside of tubing to keep it from collapsing while bending
- Geared ratchet-type bender—Used to bend tubing without damaging tube

2) Care

- Oil threads on flaring tool.
- Replace cutting wheel on cutter when dull.

k. **Iron pipe tools**

1) Use

- Pipe vise—Used to hold pipe for cutting or threading
- Dies and die head—Component pieces that are fitted into a diestock to cut threads on pipe
- Pipe reamer—Used to shape or enlarge holes in pipe
- Pipe cutter—Used to cut pipe

2) Care

- Keep tools clean and dry.

Information Sheet

l. **Drilling and boring tools**

1) Use

- Drilling tools
    - Hand drilling machine—Used for drilling on small jobs when electricity is unavailable
    - High speed drill—Used for cleaning and enlarging holes in metal and other materials, and also for drilling new holes
    - Masonry drill bits (1/8" to 1/2")—Used for drilling bathroom tile and in making holes in concrete for anchor bolts
    - Star drill bit—Used for drilling holes through wood surfaces, flooring, and beams
- Boring tools
    - Ratchet brace—Used for drilling holes in areas where space is limited
    - Wood bits (1/2", 3/4", 1")—Used in a ratchet brace
    - Expansive wood bit (3/4")—Used to bore larger holes in wood

2) Care

- Clean and oil ratchet braces after use.

m. **Threading tools**

1) Use

- Tap—Used for cutting threads inside a pipe hole (female end)
- Stock and dies—Used for cutting threads outside of pipe (male end)
- Die stock—Used to hold and turn dies
- T-handle tap wrench—Holds taps and dies during threading process
- Three-way pipe die—Used for threading three diameters of pipe with a single tool

2) Care

- Keep taps clean and oiled.

Information Sheet

n. **Copper tubing tools**

1) Use

- Striker—Provides spark for torch lighting

  Note: Extra flints for the striker should be kept in the tool box.

- Flux brush—Used to make a clean application of flux to pipe and fitting

  Note: Special flux brushes are available at stores, or old toothbrushes can be used.

- Clean towel/wiping cloth—Used for cleaning pipes and soldered joints

  Note: A good supply of clean wiping cloths should always be available.

- Sand cloth/emery paper/steel wool—Used to clean oxidized surfaces of copper pipe and fittings before applying flux

- Pocket knife—Used for reaming large copper tubing and plastic pipe and for cutting flexible plastic pipe

  Caution: Carelessness with pocket knives has caused many injuries and lost work hours.

- Yoke and screw flaring tool—Used for making mechanical joints

- Hammer flaring tool—Used to make joints on water service lines and other plumbing connections

- Swaging tool—Saves the expense of fittings by enlarging tubing ends to act as couplings

- Set of copper fitting brushes—Used to clean small fittings in preparation for soldering

  Note: Turn fitting brushes clockwise, as turning counterclockwise will reduce their effectiveness.

2) Care

- Keep striker dry, clean, and free from oil.

- Keep hammer flaring tools and swaging tools clean and lightly oiled at all times.

Information Sheet

o. **Faucet and toilet tank repair tools**

1) Use

    - Faucet handle puller—Used to remove handle from faucet

      Note: This tool should be included in every plumber's tool box since considerable damage to valves and faucets can be done by using crude methods to remove handle.

    - Valve seat dresser—Used to remove worn surfaces and burrs from valve seats
    - Hex wrench (Allen wrench)—Used for working on faucet repairs

      Note: Although this is the most common use, the hex wrench has many other uses for the plumber.

    - Valve seat wrench—Used to remove valve seats that need to be replaced
    - Tubing tap and die set—Used when repairing water closet ball cocks
    - Sink spray wrench—Used to install or replace spray attachment

2) Care

    - Keep cutting edges on valve seat dressers clean and the whole tool lightly oiled.

p. **Caulking tools**—Used to make lead joints on cast iron pipe

1) Use

    - Yarning iron—Used to pack oakum into hub end of pipe
    - Packing iron—Used to place finish coat of oakum into hub end of pipe
    - Inside caulking iron—Used to pack lead into hub end of pipe
    - Outside caulking iron—Used to place finish coat of lead into hub end of pipe
    - Caulking hammer—Used to tap caulk into place
    - Cut-off chisel—Used to cut any cold metal softer than the chisel itself, such as brass, copper, and aluminum

2) Care

    - Keep caulking tools dry and clean.

Information Sheet

q. **Polybutylene tools**

1) Use

- Crimping tools
    - Handheld—Used to crimp connectors attaching two pieces of wire together
    - Bench mounted—Used for splicing large sizes of wire with large connectors
    - Universal—Used for a variety of connector sizes; has various sizes of die holes
- Polybutylene tubing cutter—Used to make quick, clean cuts through plastic pipe and tube
- Tool set gauge—Used to measure if tools will cut accurately; includes various gauges such as drill gauge, tap and die gauge, and saw gauge
- Crimp caliper—Used to make inside and outside measurements of pipes or objects

2) Care

- Keep polybutylene tools dry and clean.

r. **Accessory hand tools**

1) Use

- Drop light—Used for light in dark work areas; has a protective reflective shield and an electrical outlet in the handle

  Note: These lights usually have 25-ft. or longer cords and should not be used as power cords for high amperage appliances such as pipe-threading machines because they are made of small gauge wire.

- Straight snips—Used for cutting vent pipe

  Note: Do not cut wire with snips.

- Nut driver—Used on hand-tightened nuts, bolts, and screws

  Note: Do not use with pliers for increased leverage.

- Pipe tap—Used to repair damaged threads
- Hex key wrench—Used to loosen or tighten socket type set screws in English and metric sizes
- Putty knife—Used for grouting the base of water closets and removing or reshaping water closet wax rings; has many other uses

Information Sheet

- Cutting oil—Used for drilling, turning, and other metal cutting operations
- Lubricating oil—Lubricates tool gears and parts and prevents rusting

2) Care

- Drop light cords should not be run over with appliance dollies or other carts.
- Keep taps clean and oiled at all times.
- Nut drivers should be used only on hand-tightened nuts, bolts, and screws; do not use pliers for increased leverage.

s. **Eye protection**

1) Use

- Safety glasses—Protect the eyes from injury due to dust and debris

  Note: These glasses are approved by the Federal Food and Drug Administration (FDA) after passing an impact resistance test; they are shatterproof, and their frames are stronger than ordinary frames.

- Goggles—Protect eyes from dust, flying particles, and splashed liquids; made of a flexible plastic body and lens

  Caution: Goggles must be worn over prescription lenses.

- Face shield—Protects the whole face from flying chips and splashed liquids

  Caution: Face shields should be worn in addition to goggles or safety glasses.

2) Care

- Keep safety glasses in a case when not using them.
- Keep glasses, goggles, and face shield clean, and store in safe area when not in use.

4. **Safety precautions for handling and storing hand tools**

a. Store tools in proper location to prevent damage to tools or possible injury to worker.

Note: Store heavy tools near the floor, light tools in higher positions such as wall racks.

b. Provide ample room to work; remove any objects that may get in the way.

c. Carry to the work area only those tools that you will need.

d. Use two or more people to move large pieces of equipment and heavy boxes.

e. Lay out your tools in an orderly fashion.

f. Hand tools to co-workers; never throw them.

Information Sheet

g. Wear gloves for protection against heat and flying debris.

h. Wear eye and face protection to prevent injury from splattering liquids or flying debris.

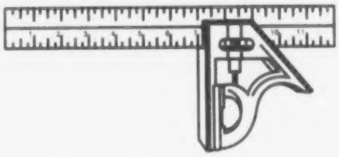
i. Avoid carrying sharp instruments such as screwdrivers in pockets where ends will protrude.

j. Keep such items as gas hoses and electric cords neat and orderly and not in a tangled mess.

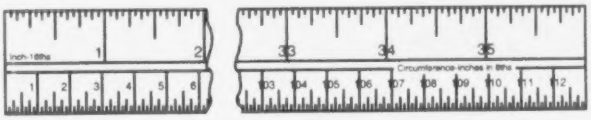
k. Keep electric cords away from water.

l. Wash hands after handling tools and before eating.

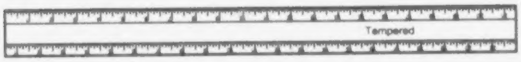
5. Rules used for measuring



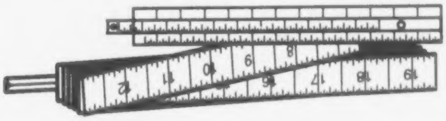
a. Combination square



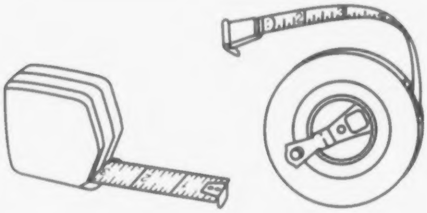
b. Circumference rule



c. Steel rule



d. Folding rule



e. Steel tape

6. Guidelines for the use and care of rules and steel tapes

a. Use the proper length and graduation.

b. Use finest graduation for accuracy.

c. Use a good quality rule.

Note: Plumbing measurements must be accurate to a fraction of an inch and instruments must be capable of such accuracy.

d. Use rule on edge for accurate reading.

e. Use lower edge of circumference rule for figuring circumferences only.

f. Never bend or distort a steel rule.

g. Use rules only for their intended purpose.

h. Apply a small amount of fine oil to the joints of folding rules in order to lessen wear.

i. Avoid dropping folding rules on ends as joints can be loosened causing inaccuracies in measurement.

Note: Each joint inaccuracy can multiply over the length of the rule.

j. Use care in handling wooden rules.

Note: Avoid buying cheap rules as they break easily.

k. Keep steel tapes clean and lightly oiled.

Note: Dirt and other abrasives wear away the numbers and cause destruction of the rewinding mechanism.

l. Keep steel tapes away from moisture as it will damage the rewind mechanism.

m. Rewind steel tapes slowly to avoid breakage and excessive wear.

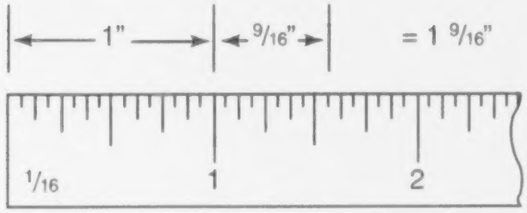
7. Reading a rule/tape measure

Note: Rules are available in varied graduations such as quarters, eighths, and sixteenths, but the principles for reading them are similar.

a. Count the divisions in one inch.

b. Count the graduations after the last full inch.

c. Add fractions to the last full inch.



d. Reduce the fraction if possible.

Hand Tools
Unit 1-B

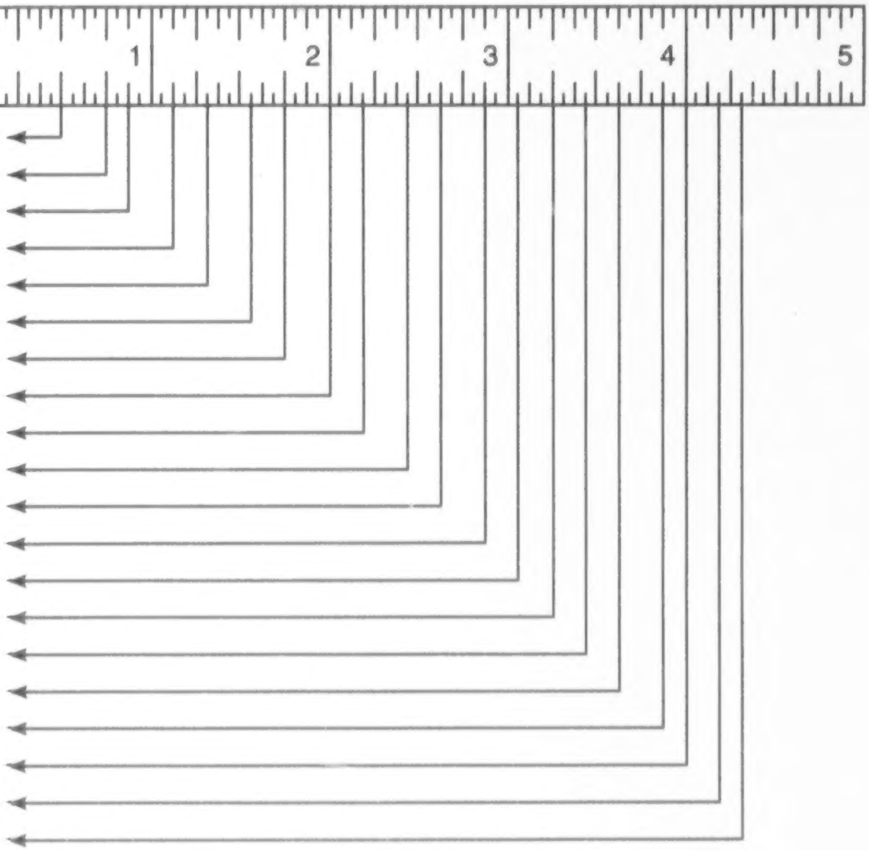
Assignment Sheet 1—Read a Rule/Tape Measure

Name ______________________________ Overall Rating ______________

Evaluation Criteria	**Rating**
• Directions have been followed	______
• Answers are correct	______
• Assignment is neat and completed on time	______

Directions: Determine the correct dimension for each arrow. Write your answers in the blanks provided.

Example: Arrow 1 = $^1/_2$″



______ 1.
______ 2.
______ 3.
______ 4.
______ 5.
______ 6.
______ 7.
______ 8.
______ 9.
______ 10.
______ 11.
______ 12.
______ 13.
______ 14.
______ 15.
______ 16.
______ 17.
______ 18.
______ 19.
______ 20.

Hand Tools
Unit 1-B

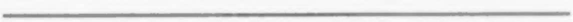
Assignment Sheet 2—Measure Lines to the Nearest Quarter, Eighth, and Sixteenth of an Inch

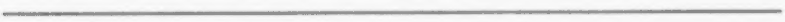
Name ______________________________ Overall Rating ______________

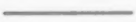
Evaluation Criteria	**Rating**
• Directions have been followed	________
• Answers are correct	________
• Assignment is neat and completed on time	________

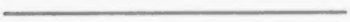
Directions: Measure the lines according to the instructions and write your answers in the blanks provided.

1. Measure these lines to the nearest quarter of an inch.

a.


b.


c.


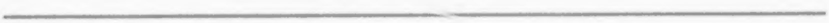
d.


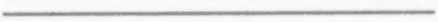
Answers

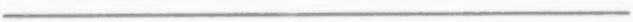
a. ____________ b. ____________

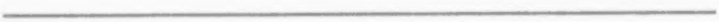
c. ____________ d. ____________

2. Measure these lines to the nearest eighth of an inch.

a.


b.


c.


d.


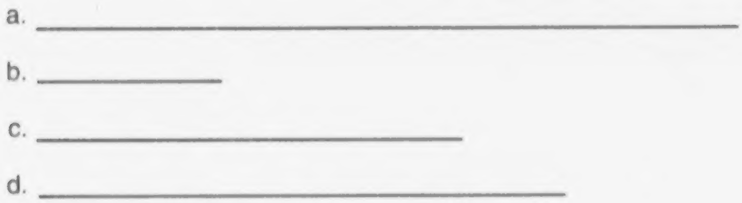
Answers

a. ____________ b. ____________

c. ____________ d. ____________

Assignment Sheet 2

3. Measure these lines to the nearest sixteenth of an inch.



Answers

a. ____________ b. ____________

c. ____________ d. ____________

Hand Tools
Unit 1-B

Job Sheet 1—Use Hand Tools to Inspect/Replace a Washer on a Globe Valve

Name ______________________________ Attempt Number ______________

Date ______________________________ Overall Rating ______________

Evaluation Criteria	**Rating**
• Tools and equipment were used correctly	______
• Washer was inspected for defects	______
• Work was neat and completed in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

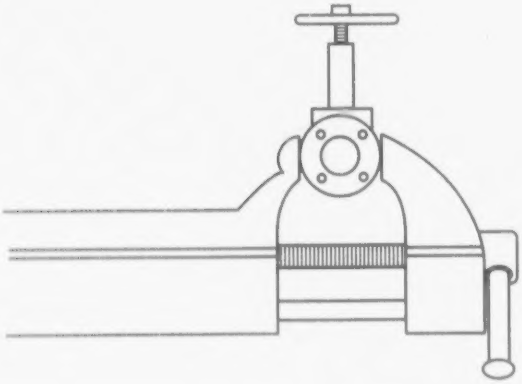
- Screwdriver
- Adjustable wrench
- Bench vise
- Globe valve
- New washer

B. Procedure

☐ 1. Place valve in vise. (Figure 1)

Caution: Do not damage valve by overtightening vise.

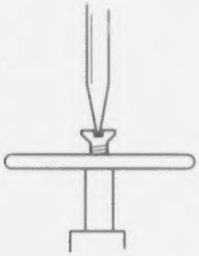
FIGURE 1



☐ 2. Unscrew the valve wheel screw and remove the valve wheel. (Figure 2)

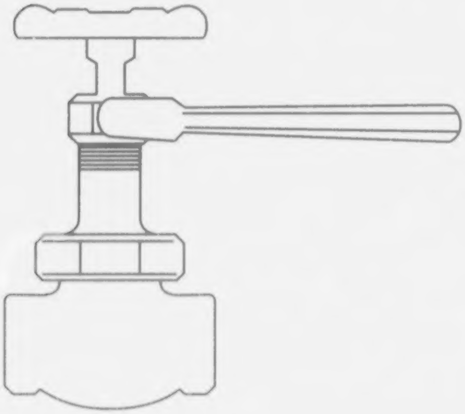
Job Sheet 1

FIGURE 2



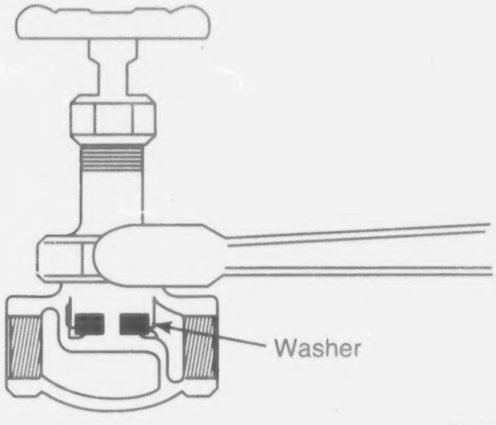
☐ 3. Loosen packing nut on valve stem. (Figure 3)

FIGURE 3



☐ 4. Remove valve stem by loosening bonnet. (Figure 4)

FIGURE 4



☐ 5. Inspect washer for defects; replace if needed.

Job Sheet 1

☐ 6. Replace valve stem assembly (stem, bonnet, packing nut).

☐ 7. Replace valve wheel and wheel screw.

Evaluator's Comments: ______________________________

____

____

Hand Tools
Unit 1-B

Job Sheet 2—Measure and Mark a Predetermined Length of Pipe

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Measurement is accurate	______
• Tools were handled properly	______
• Work was completed in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Six-foot folding rule or steel tape
- Pencil
- Length of pipe

B. Procedure

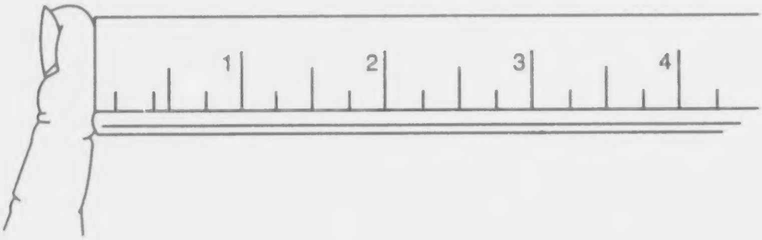
☐ 1. Place pipe in suitable position for measuring.

☐ 2. Determine correct measurement to be made.

☐ 3. Open folding rule or unroll steel tape and lay on top of pipe.

☐ 4. Place finger over end of pipe and butt rule up against finger. (Figure 1)

FIGURE 1

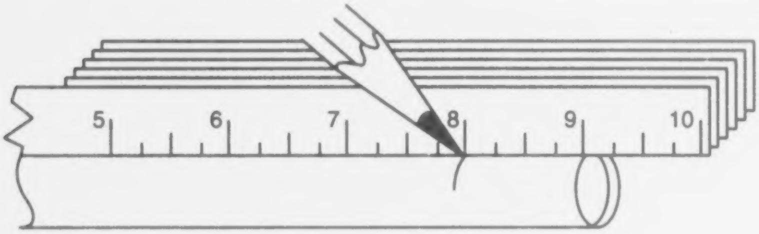


☐ 5. Hold rule firmly on pipe and read predetermined measurement on rule.

Job Sheet 2

☐ 6. Mark pipe with pencil at point of rule measurement. (Figure 2)

FIGURE 2



Evaluator's Comments: ____________________

____

____

Hand Tools
Unit 1-B

Job Sheet 3—Use Hand Tools to Cut a Length of Steel Pipe

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Tools were used correctly	______
• Cut was made accurately	______
• Work was neat and completed on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Pipe vise
- Pipe cutter
- Steel pipe
- Safety glasses
- Shop towel
- Pencil

B. Procedure

☐ 1. Put on safety glasses and gather tools and equipment

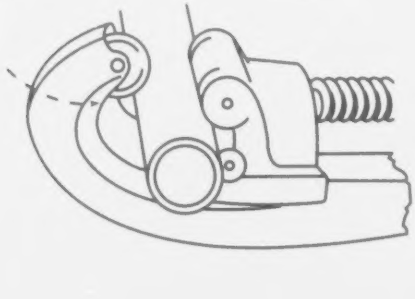
☐ 2. Secure pipe in vise.

☐ 3. Mark place for cut with pencil.

☐ 4. Open pipe cutter until it will fit over pipe.

☐ 5. Locate cutter wheel on the pencil mark. (Figure 1)

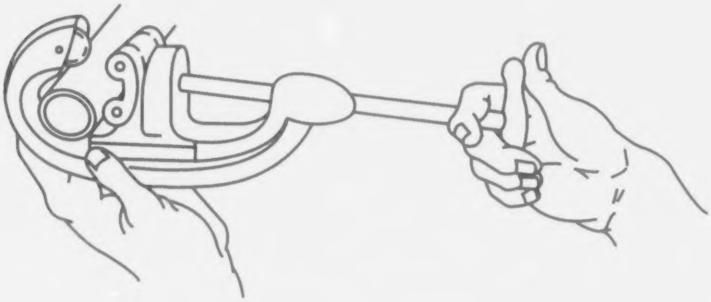
FIGURE 1



Job Sheet 3

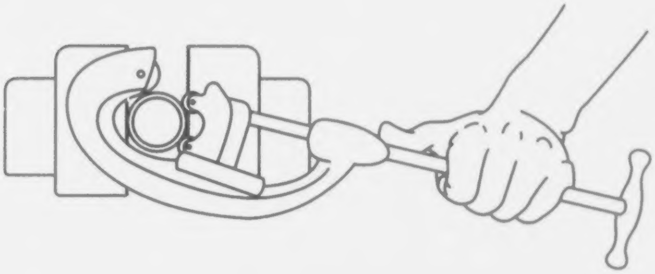
☐ 6. Snug cutter up to pipe by rotating screw handle. (Figure 2)

FIGURE 2



☐ 7. Rotate cutter counterclockwise to start groove. (Figure 3)

FIGURE 3



☐ 8. Tighten cutter 1/4 of a turn for each full revolution around the pipe.

Note: Over tightening can cause cutters to break or bend pipe.

☐ 9. Continue process until pipe is cut.

Caution: When cutting short pieces of pipe, be careful not to cut your arm while rotating the cutter around the pipe.

☐ 10. Clean pipe and cutter with shop towel.

☐ 11. Have instructor inspect your work.

Job Sheet 3

☐ 12. Clean up work area.

Evaluator's Comments: ______________________________

Hand Tools
Unit 1-B

Job Sheet 4—Use Hand Tools to Ream Steel Pipe

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Proper safety precautions were taken	______
• Tools were used correctly	______
• Work was performed accurately	______
• Work was neat and completed on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Pipe vise
- Reamer
  Note: You will need a ratchet handle or brace, depending on which type of reamer you use.
- Piece of steel pipe
- Safety glasses
- Shop towel

B. Procedure

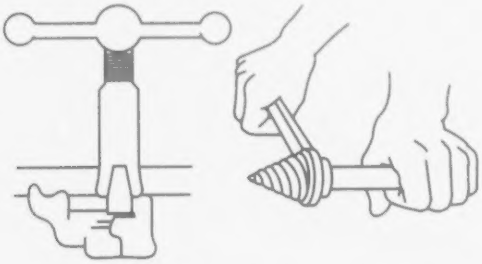
Caution: Be careful around cut pieces of steel pipe. Sharp ridges or spurs can cause deep cuts.

☐ 1. Put on safety glasses and gather tools and equipment.

☐ 2. Place pipe in vise.

☐ 3. Insert reamer tip in pipe. (Figure 1)

FIGURE 1

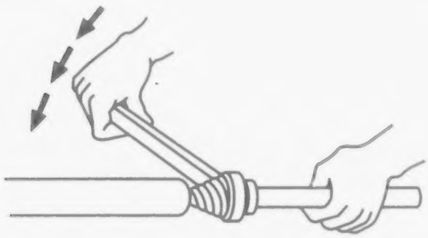


☐ 4. Apply light forward pressure to push reamer into pipe.

☐ 5. Start rotating reamer. (Figure 2)

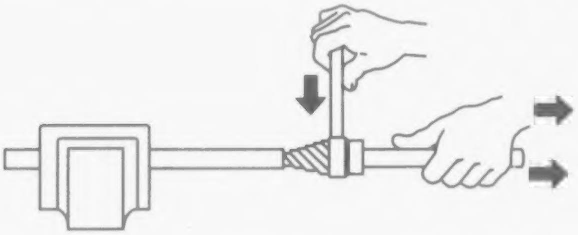
Note: Reamer should bite instantly if proper pressure is applied. Reamer can be damaged if rotated in the wrong direction.

FIGURE 2



☐ 6. Rotate reamer until burrs are removed. (Figure 3)

FIGURE 3



Note: This is a developed skill. You can pull out the reamer and inspect your progress.

☐ 7. Pull reamer back while continuing to rotate. (Figure 3)

Note: This prevents the reamer from leaving a burr.

☐ 8. Have your instructor inspect your work.

☐ 9. Clean pipe and reamer with shop towel.

☐ 10. Clean up work area.

Evaluator's Comments: ______________________

____

____

Hand Tools
Unit 1-B

Job Sheet 5—Use Hand Tools to Cut Pipe Threads

Name ____________________ Attempt Number __________

Date ____________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Proper safety precautions were taken	______
• Tools were used correctly	______
• Work was performed accurately	______
• Work was neat and completed on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

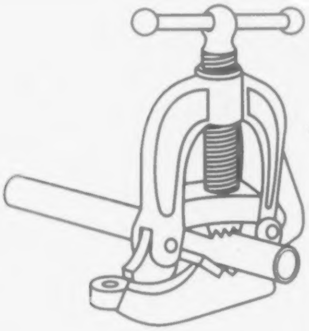
- Die
- Die stock
- Vise
- Flat file
- Oil can (cutting oil)
- Steel pipe
- Safety glasses

B. Procedure

☐ 1. Put on safety glasses and gather tools and equipment.

☐ 2. Place pipe in vise. (Figure 1)

FIGURE 1



☐ 3. Lubricate end of pipe with cutting oil.

Job Sheet 5

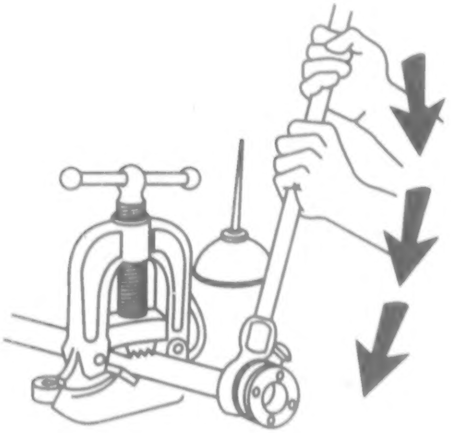
☐ 4. Place die in die stock and secure.

☐ 5. Place die on pipe.

☐ 6. Start die straight on the pipe.

☐ 7. Press evenly and turn the die. (Figure 2)

FIGURE 2



☐ 8. Apply plenty of cutting oil while turning the die.

Note: Place a container under pipe vise to catch dripping oil.

☐ 9. Continue this procedure until the desired amount of threads have been cut.

☐ 10. Remove die by turning counterclockwise.

Note: Hold onto the die stock firmly while removing it so you won't drop it when it comes to the end of the threads.

☐ 11. Clean threads with a brush.

Caution: Do not use compressed air for cleaning.

☐ 12. Have instructor inspect your work.

☐ 13. Clean up work area.

Evaluator's Comments: ______________________

____

____

Hand Tools
Unit 1-B

Job Sheet 6—Set Up and Use a Hacksaw to Cut a Length of PVC Pipe

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Proper safety precautions were taken	______
• Tools were used correctly	______
• Cut was made accurately	______
• Work was neat and completed on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Hacksaw frame
- Hacksaw blade
  Note: For cutting pipe a 24 or 32 teeth/inch blade is recommended.
- PVC pipe
- Pipe vise
- Safety glasses

B. Procedure

☐ 1. Put on safety glasses and gather tools and equipment.

☐ 2. Insert blade in frame and tighten. (Figures 1–2)

Note: Be sure teeth angles are pointed toward the front of the saw.

FIGURE 1

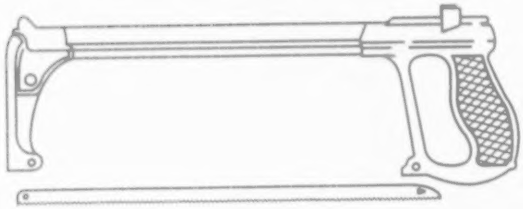
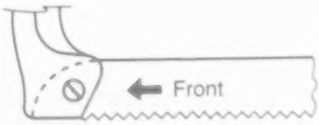


FIGURE 2

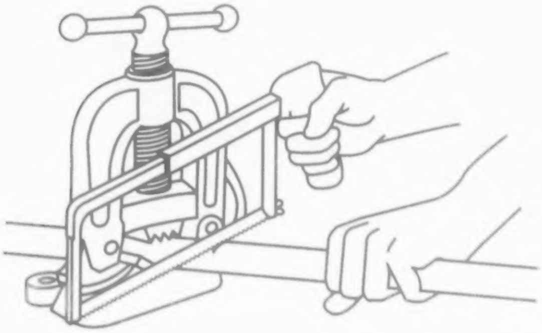


Note: Hand tighten only; being too tight can cause the blade to shatter.

Job Sheet 6

☐ 3. Secure pipe for cutting. (Figure 3)

FIGURE 3



☐ 4. Rest the blade on the pipe at the point to be cut.

☐ 5. Push forward gently until cut is started.

Note: Exert downward pressure *only* on the forward stroke.

☐ 6. Make reciprocal strokes until cut is finished.

Note: Excessive speed while cutting can ruin blades. You should not use over thirty full strokes per minute.

☐ 7. Have instructor check your cut.

Note: Your cut should be straight and relatively smooth.

☐ 8. Clean up work area.

Evaluator's Comments: ____

____

____

Power Tools
Unit 2-B

Objective Sheet

Unit Objective

After completing this unit, the student should be able to identify the power tools used in the plumbing trade and demonstrate their proper use and care. The student should demonstrate these competencies by completing the job sheets and by scoring a minimum of 85 percent on the written test.

Note: The student must score 100 percent on the safety section of the test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to power tools with the correct definitions.
2. Identify power tools used in the plumbing trade.
3. Discuss the use and care of power tools used in the plumbing trade.
4. List safety precautions for power tools used in plumbing.
5. Install a lavatory hanger on a concrete wall. (Job Sheet 1)
6. Cut out a bathtub drain opening in a plywood floor. (Job Sheet 2)
7. Thread steel pipe with a portable power-driven vise stand. (Job Sheet 3)

Power Tools
Unit 2-B

Information Sheet

1. **Terms and definitions**

   a. **Abrasive**—Cutting and grinding of material by a thin wheel made of a hard, stone-like substance

   b. **Power tools**—Tools which are operated with electricity, air, or gasoline

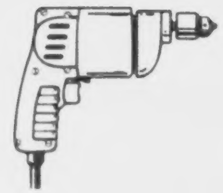
   c. **Reciprocating**—Moving in a back and forth motion, as opposed to a circular motion

   d. **Roughing-in tools**—Tools, both hand and power, used to install the initial stage of the building's plumbing, including cutting and drilling access holes and connecting piping

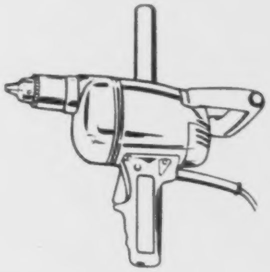
2. **Power tools used in the plumbing trade**

   a. **Drilling machines**

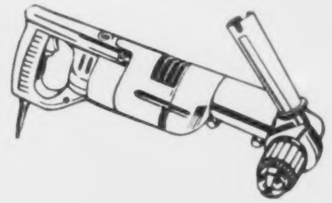
   Note: These are often referred to as drills. The sizes of drilling machines are classified by the maximum size straight shank drill they will hold.



- Electric drill—1/4"

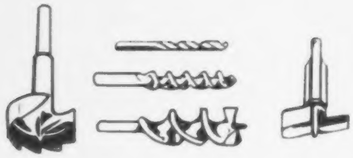


- Electric drill—1/2" straight

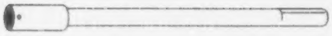


- Electric drill—1/2" angle

Information Sheet

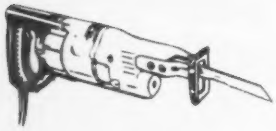


- Assortment of wood bits



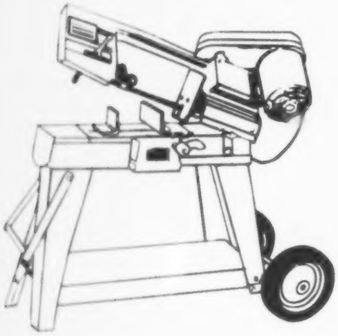
- Extension

b. **Saws**

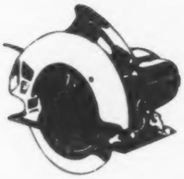


- Portable electric saw

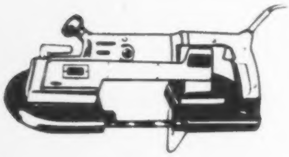
- Hole saw



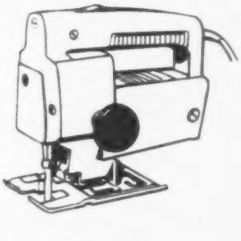
- Bench band saw



- Circular saw



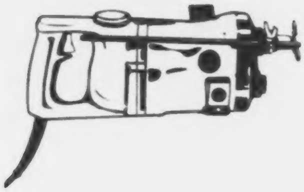
- Band saw (portable)



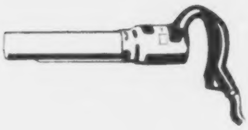
- Saber saw

Information Sheet

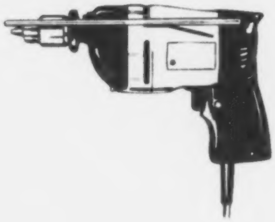
c. Concrete tools



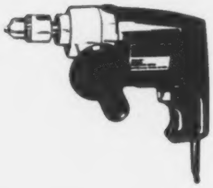
- Electric rotary hammer



- Air hammer



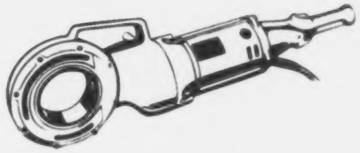
- 3/8" hammer drill



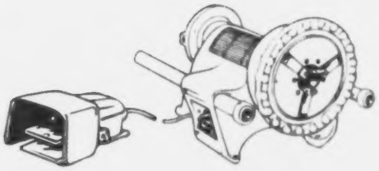
- Electric chipping hammer

d. Threading machines

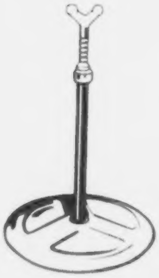
- Portable electric pipe threader



- Portable power drive



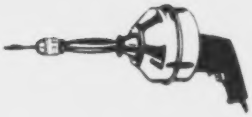
- Portable power-driven vise stand



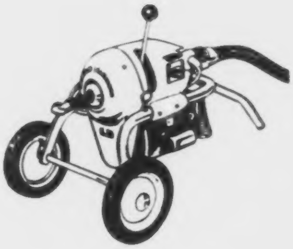
- Pipe support

Information Sheet

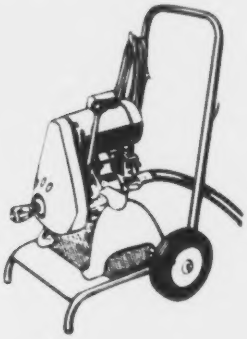
e. **Sewer and drain cleaning equipment**



- Electric snake



- Power drain cleaner, electric



- Power drain cleaner, compressed air or gasoline

- Glove

3. Use and care of power tools used in the plumbing trade

a. **Drilling machines**

- Small drills ($^1/_4$") develop more RPMs than large drills because the larger units are designed to turn larger cutting tools or to drill in heavy materials, and both of these factors require a slower speed.
- The chuck key should be strapped to the power cord.
- The cutting tool must be kept sharp in order to avoid forcing the machine and causing unnecessary wear and short life.

  Note: Before cutting out for pipe, make sure all nails have been pulled from the area.
- Drilling machines should be kept in the storage box when not in use in order to avoid damage.

Information Sheet

b. **Saws**

- Saw blades should be kept sharp in order to avoid excessive forcing of the machine.
- Portable electric circular saws are used for cutting lumber, but can be fitted with abrasive wheels to cut metal and concrete.
- Power saws should be operated at a limited speed of cut in order to avoid blade breakage.
- Reciprocating power saws are often used for cutting irregular shaped pipe holes and openings, especially in difficult to reach places.
- Small reciprocating power saws (saber saws) are helpful in cutting out countertops for kitchen sinks.
- Hole saws cut holes in wood or metal.

c. **Concrete tools**

- Used for cutting into and through concrete
- Hammer drills make holes in concrete by "hammering" the rotating bit.
- Air hammers are used to break up large sections of concrete and to make large holes.
- Circular saws (abrasive wheels) are used to cut openings for pipes in concrete walls, floors, and ceilings.

d. **Threading machines**

- Used for cutting threads to save time and energy
- Especially helpful on large jobs where a great deal of thread cutting is required
- Threading machines are necessary for cutting threads on pipe larger than 2".
- Threading machines usually cut, ream, and thread pipe.

e. **Sewer and drain cleaning equipment**

- Handheld drain cleaning machines are used to clean out obstructions in waste pipes.
- Power sewer cleaners are designed to clean out soil and sewer pipes with powerful motors and long, strong cables.

4. **Safety precautions for power tools used in plumbing**

a. Know the tool you are using, its application, limitations, and potential hazards.

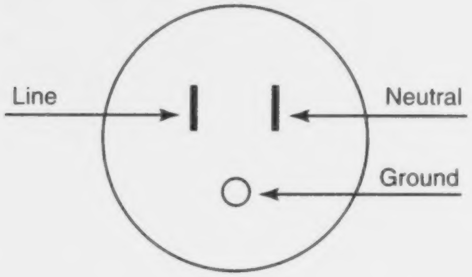
b. Select the proper tool for the job.

- Don't try to tackle a big job with an undersized tool.
- Makeshift tools cause accidents.

Information Sheet

c. Ground all tools unless double insulated.

- Three-prong plug should be plugged into a three-hole electrical receptacle.



- If you use an adapter to accommodate a two-prong receptacle, you must attach the adapter wire to a known ground.

Caution: Never remove the ground plug from any electrical cord.

d. Remove adjusting keys and wrenches before turning on tool.

e. Keep work area free of clutter.

Note: Boards, boxes, debris, and tools can be tripping hazards.

f. Keep guards in place and in working order.

- Do not remove.
- Do not wedge out of the way.

g. Always be alert to potential hazards in your working environment.

- Be very cautious of damp locations when working with electricity.
- Be aware of the presence of highly combustible materials such as gasoline and naphtha.

h. Avoid accidental startup.

- Make sure switch is off before plugging in cord.
- Turn power switch off when power is interrupted.

Note: Don't carry plugged in tool with finger on switch.

i. Make sure saw blades, drill bits, and cutters are sharp, clean, and regularly maintained.

j. Use only accessories recommended by the manufacturer.

Information Sheet

k. Do not force tool.

Note: It will do a better and safer job at its designed speed.

l. Wear safety glasses.

Note: Also use face or dust mask if operation requires it.

m. Do not overreach.

Note: Keep proper footing and balance at all times.

n. Never leave power tool running unattended.

- Don't leave until it comes to a complete stop.
- Don't leave until it is disconnected from power source.
- Don't remove drill or bit until machine has stopped running.

o. Don't surprise or touch anyone operating a power tool.

Note: The distraction could cause a serious accident.

p. Never adjust or change bits, blades, or cutters with tool connected to power.

q. Dress properly.

- Avoid loose clothing that could catch in moving parts.
- Wear rubber boots in damp locations.
- Gloves can be caught by revolving machinery.

r. Secure work.

Note: Use clamps or vise to hold work when practical. This can free both hands to operate tool.

s. Do not use tool with frayed cord.

Note: Return frayed cords for servicing. Use only heavy-duty UL listed extension cords of proper wire size and length.

t. Never brush away chips or sawdust while tool is operating.

u. Do not attempt field repairs.

Note: Return for servicing any tool that shows the slightest defect or is not operating properly.

v. Store tools in dry, secure location where they won't be tampered with or stolen.

Power Tools
Unit 2-B

Job Sheet 1—Install a Lavatory Hanger on a Concrete Wall

Name ______________________________ Attempt Number ____________

Date ______________________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Tools and equipment were used correctly	______
• Washer was inspected for defects	______
• Work was neat and completed on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Lavatory
- Lavatory hanger
- Rough-in hook
- Seven anchor bolts (3/8″ x 1 1/2″)
- Drilling machine, 3/8″
- Masonry drill, 3/8″
- Straight screwdriver, medium
- 6′ rule or steel tape
- Pencil
- Electrical extension cord
- Seven 3/8″ steel washers
- Level
- Safety glasses

B. Procedure

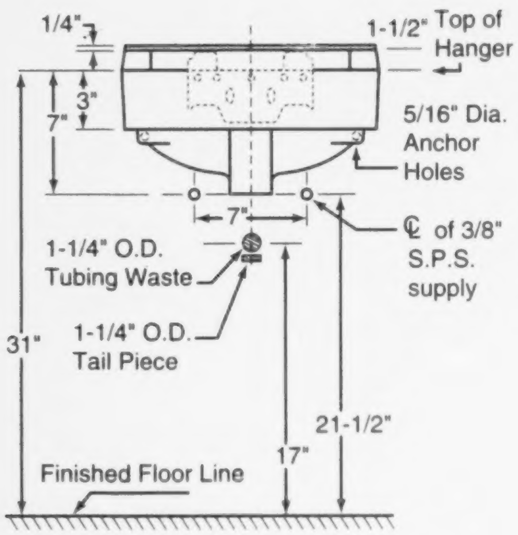
☐ 1. Put on safety glasses, and gather equipment and materials.

☐ 2. Study the rough-in book and determine height of the lavatory hanger installation. (Figure 1)

Note: Elongated holes in hanger allow for moving the hanger up or down about 1/2″.

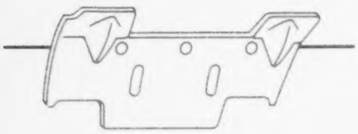
Job Sheet 1

FIGURE 1



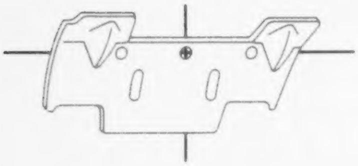
☐ 3. Mark the wall (horizontally) where the hanger is to be installed. (Figure 2)

FIGURE 2



☐ 4. Determine vertical location and mark the wall. (Figure 3)

FIGURE 3

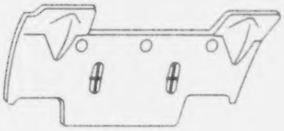


Job Sheet 1

☐ 5. Hold the washer on the wall over the marks, and mark location of bolt holes in elongated holes. (Figure 4)

Note: Center the bolt hole mark.

FIGURE 4



☐ 6. Place the masonry drill in the drilling machine and tighten the chuck.

☐ 7. Connect the drilling machine to electrical outlet using an extension cord, if necessary.

☐ 8. Drill bolt holes for the elongated holes in the hanger.

Note: Drill hole 1/4″ longer than anchor bolt.

☐ 9. Push anchors into bolt holes.

Note: The anchor should be flush with the hole opening.

☐ 10. Place the lavatory hanger on the bolt holes and insert the two screws with washers into the anchors.

☐ 11. Tighten the two screws and place the lavatory on the hanger.

☐ 12 Check for correct height.

Note: Rim height should be 31″.

☐ 13. Adjust hanger height if necessary.

Note: Loosen anchor bolts if an adjustment is to be made.

☐ 14. Drill the remaining holes with the hanger bolted in the correct position.

Note: Level all work as the job progresses.

☐ 15. Place lavatory on hanger and make final check for height and level.

☐ 16. Have instructor inspect your work.

Job Sheet 1

☐ 17. Clean up work area.

Evaluator's Comments: ______________________________

____

____

Power Tools
Unit 2-B

Job Sheet 2—Cut Out a Bathtub Drain Opening in a Plywood Floor

Name ____________________ Attempt Number __________

Date ____________________ Overall Rating __________

Evaluation Criteria	Rating
• Cut is accurate	______
• Tools were handled properly	______
• Work was neat and completed on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Reciprocating power saw
- Short, pointed wood cutting blade
- Electrical extension cord
- 6′ rule or steel tape
- Pencil
- Safety glasses

B. Procedure

Note: Simulate a bathroom floor in the lab.

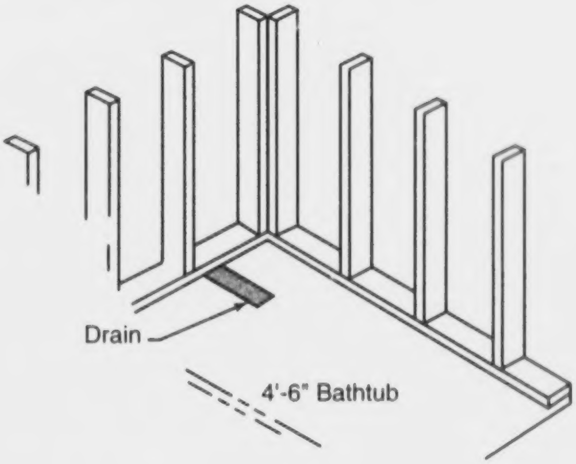
☐ 1. Gather all tools and equipment and carry to the job site.

☐ 2. Mark out location of bathtub drain. (Figure 1)

Note: Usually a 10″ x 5″ hole is cut. Check for floor joists and other hidden objects.

Job Sheet 2

FIGURE 1



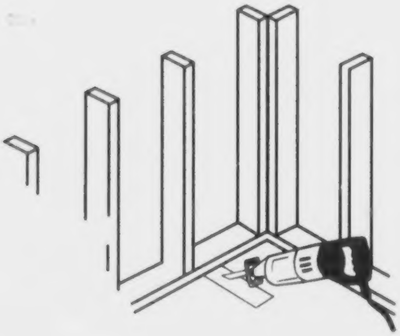
☐ 3. Install correct blade in saw.

Note: Make sure blade is tight and in correct position.

☐ 4. Connect saw to source of power.

☐ 5. Hold the saw low and start the cut in the center of the marked out area. (Figure 2)

FIGURE 2

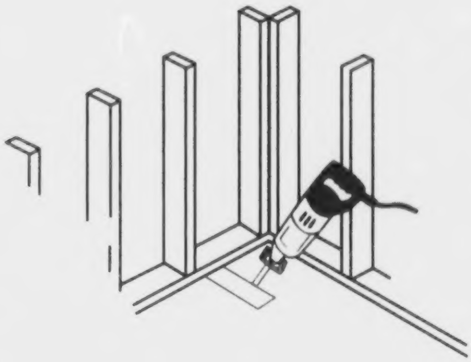


☐ 6. Press the moving blade down and penetrate the plywood, gradually bringing the saw from horizontal to near vertical position.

Job Sheet 2

☐ 7. Cut to the line and follow the line around the entire rectangle. (Figure 3)

FIGURE 3



☐ 8. Remove blade from saw.

☐ 9. Have instructor inspect your work.

☐ 10. Clean up work area.

Evaluator's Comments: ____

____

____

Power Tools
Unit 2-B

Job Sheet 3—Thread Steel Pipe With a Portable Power-Driven Vise Stand

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Tools were used correctly	______
• Threads were made properly	______
• Work was neat and completed on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Portable power-driven vise stand
- Clean cloth
- Safety glasses
- 2″ diameter steel pipe
- Pipe cutter
- Oil can and cutting oil

B. Procedure

☐ 1. Put on safety glasses, and gather equipment and materials.

☐ 2. Insert pipe into chuck and tighten.

☐ 3. Place cutter on pipe and allow handle of cutter to rest against either one or both bars as required.

☐ 4. Start machine and control cutting action of cutter through handle.

☐ 5. Ream pipe in similar manner.

☐ 6. Stop machine.

☐ 7. Start 2 or 3 threads on pipe by hand with ratchet-type dies.

☐ 8. Start machine and cut required number of threads, keeping oil on die stock until appropriate threads are cut.

☐ 9. Stop machine, push bars back, and remove dies from pipe by hand.

Job Sheet 3

☐ 10. Have instructor evaluate job.

☐ 11. Clean up work area.

Evaluator's Comments: ____

____

____

Equipment
Unit 3-B

Objective Sheet

Unit Objective

After completing this unit, the student should be able to identify the equipment used in the plumbing trade and demonstrate their proper use and care. The student should demonstrate these competencies by completing the job sheets and by scoring a minimum of 85 percent on the written test.

Note: The student must score 100 percent on the safety section of the test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to equipment with the correct definitions.
2. Identify equipment generally used in plumbing.
3. Match types of equipment with the correct use and care statements.
4. List safety precautions related to operating an air-acetylene torch outfit.
5. Light and adjust the air-acetylene torch. (Job Sheet 1)
6. Set up and adjust the builder's level. (Job Sheet 2)
7. Set up an inflatable rubber test plug in a pipe. (Job Sheet 3)
8. Set up a mechanical test plug in a pipe. (Job Sheet 4)
9. Set up and operate a ratchet lever hoist. (Job Sheet 5)

Equipment
Unit 3-B

Information Sheet

1. **Terms and definitions**

   a. **Acetylene**—A colorless, gaseous hydrocarbon made by the action of water on calcium carbide which is used as a fuel

   b. **Bench grinder**—Electric powered grinding wheel used to sharpen tools and wear away excess metal from various objects

   c. **Hoist**—Instrument used to lift heavy objects with the least amount of strain on the worker

   d. **Optical instruments**—Instruments used to determine grade when installing long lengths of pipe

   e. **Propane**—A heavy, flammable, gaseous, paraffin hydrocarbon found in crude petroleum and natural gas which is used as a fuel

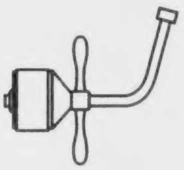
   f. **Test**—Isolating a piping system with plugs of various types and applying air pressure, water, smoke, or other agents in order to check for leaks in the system

   g. **Torch**—Tool used to create a controlled flame which is used for soldering copper fittings

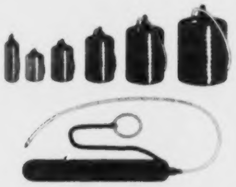
   h. **Trench**—Excavation made for the installation of pipe

2. **Equipment generally used in plumbing**

   a. **Test equipment**



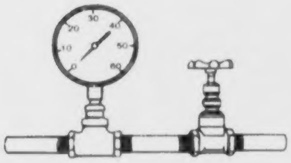
- Mechanical test plug



- Inflatable rubber test plug

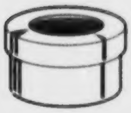
Courtesy of Cherne Industries

- Tire pump

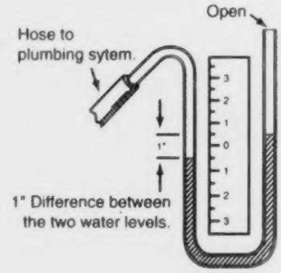


- Test gauge assembly

Information Sheet



- Test cap



- Manometer

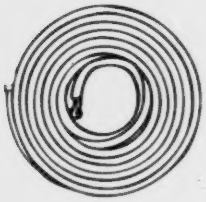
b. **Torches**

- Air-acetylene torch outfit

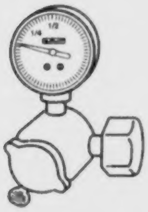
— "MC" acetylene tank

— "B" acetylene tank

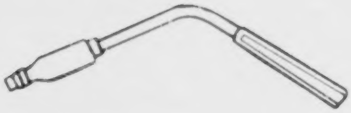
— Torch handle



— Hose

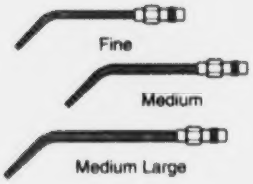


— Regulator

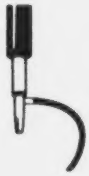


— High temperature wrap around flame tip

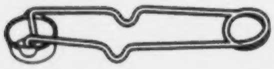
Information Sheet



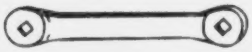
- Tips



- Halide torch leak detector



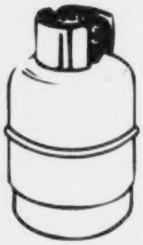
- Striker



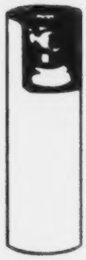
- Cylinder wrench

• Air-propane torch outfit

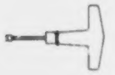
Note: This torch outfit contains many of the same items as the air-acetylene torch outfit.



- Liquefied petroleum cylinder, 20 lbs. capacity, propane tank

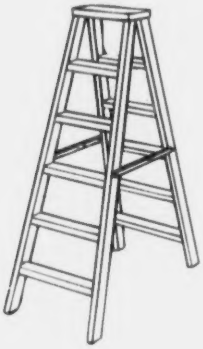


- Liquefied petroleum cylinder, 2 1/2 lbs. capacity
- Torch handle
- Regulator
- High temperature wrap around flame tip
- Standard tips
- Halide torch leak detector
- Striker
- Hose

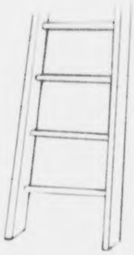


- Tank key

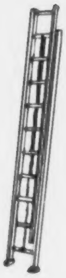
c. **Ladders**



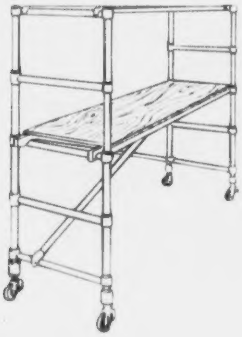
- Stepladder



- Single ladder

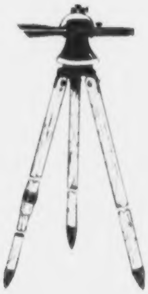


- Extension ladder

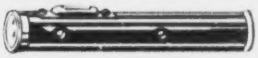


- Scaffolding

d. **Site layout and measuring tools**

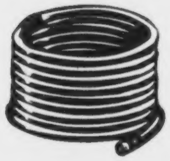


- Builder's level



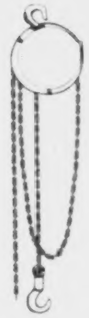
- Hand level

Information Sheet

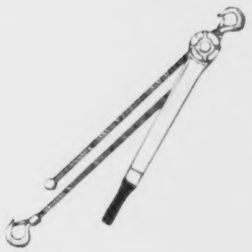


- Rubber hose

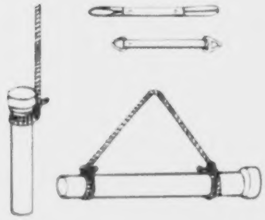
e. **Hoists**



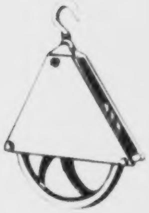
- Hand chain hoist



- Ratchet lever hoist

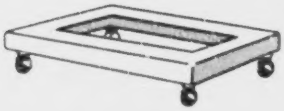


- Ropes and slings

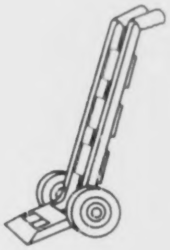


- Gin block

f. **Dollies and hand trucks**



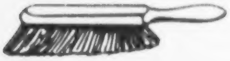
- Dolly



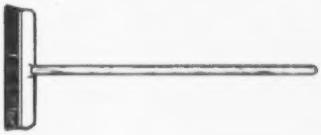
- Hand truck

Information Sheet

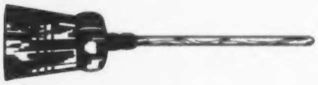
g. **Cleaning equipment**



- Bench brush

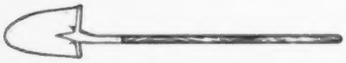


- Push broom

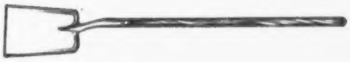


- Hand broom

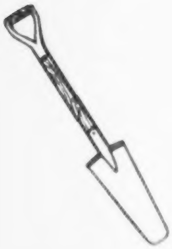
h. **Excavating equipment**



- Round point shovel

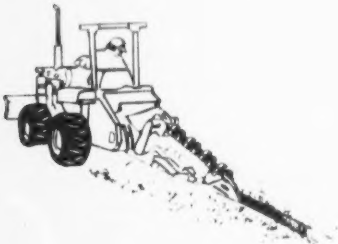


- Square point shovel

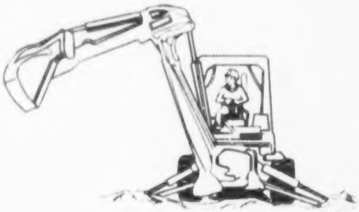


- Sharp shooter shovel

Note: The above shovels are made with long and short handles.



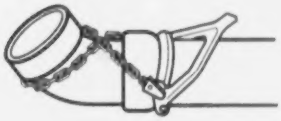
- Power trencher



- Backhoe

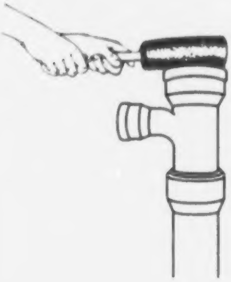
Information Sheet

i. Cast iron pipe assembly tools

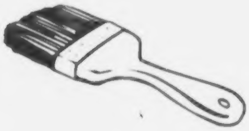


- Pipe puller

- Lubricant

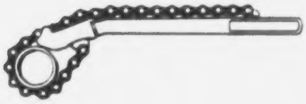


- Lead hammer
  Courtesy of Tyler Pipe Company

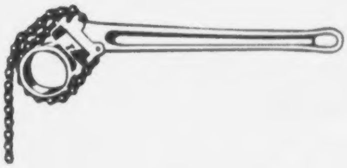


- Lubricant brush

j. Wrenches

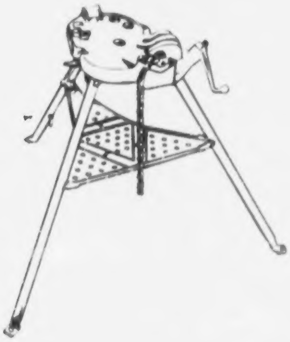


- Light duty chain wrench



- Heavy duty chain wrench

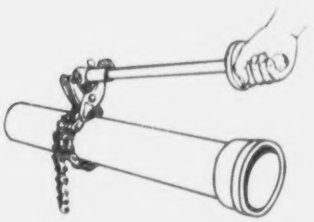
k. Pipe cutting equipment



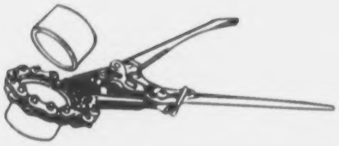
- Vise stand

Information Sheet

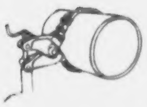
I. **Cast iron pipe cutters**



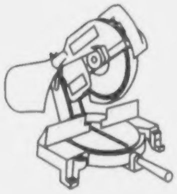
- Ratchet cutter



- Squeeze-type cutter



- Hydraulic cutter



- Circular miter saw

3. **Use and care of equipment**

   a. **Test equipment**

   - Mechanical test plugs are used to seal a drainage system or part of a drainage system in order to check for leaks.
   - Tire pumps are used to inflate rubber test plugs after they are inserted in the piping system.
   - Test gauge assembly is used to attach the air pump to the piping system being tested and to show the amount of pressure on a gauge.
   - Test caps are used to seal ends of pipes in order to seal the system for a test.
   - The manometer is a device used to measure the amount of pressure developed in a piping system being tested.

   b. **Torches**

   - Torches are used to heat copper tube and melt solder to make sweat joints.
   - Torch tips must be handled carefully in order to avoid denting and crimping.

     Note: A damaged tip can cause a faulty flame.

   - Torches must be kept clean.

     Note: Molten solder falling onto a torch can clog the air vents and torch tip.

   - Proper tools must be used to open gas tanks: a "T" wrench for propane tanks, a cylinder wrench for acetylene tanks.

Information Sheet

c. Ladders

- The stepladder is used when working short distances above ordinary reach level.
- Stepladders are handy for climbing in and out of trenches which are 4′–6′ deep.

  Note: Trenches over 6′ deep should be provided with single ladders which extend above the top of the trench.
- Single ladders are used to reach the roof of single-story buildings.

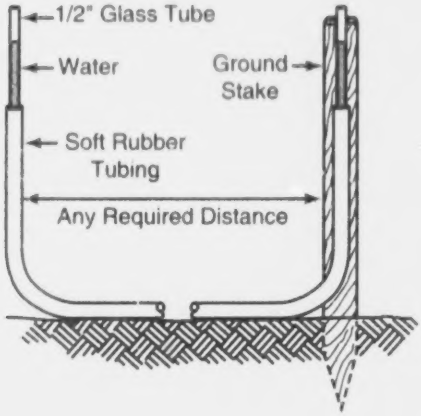
  Note: Legs of single and extension ladders should be secured in order to avoid slipping.
- Single ladders are used in new buildings where no staircases have been installed.

  Caution: Do not use stepladders to reach areas which necessitate standing on the top step of the ladder.
- Extension ladders are used to reach the roof of two-story buildings.
- Scaffolds are usually provided by bricklayers, plasterers, and/or painters and are sometimes used by plumbers to reach high places in a building.

  Caution: Care should be taken when working on scaffolds, as their construction and set-up is not always safe.

d. Layout and measuring tools

- Plumbers use the builder's level primarily to determine the pitch of long runs of pipe.
- Since long runs of piping are mostly underground installations, trench excavations are usually determined with the use of the builder's level.
- Hand levels are useful for making rough measurements of trench depths.
- A handy way to develop pitch measurement on long runs, when builder's levels are not present, is to use a length of rubber hose.



Information Sheet

e. **Hoists**

- Hand chain hoists are used to raise or lower heavy objects or to hold them temporarily in position.
- A hand chain hoist or ratchet lever hoist will lift or pull heavy loads for short distances.
- Ropes and slings help make lifting easier and help prevent strains and bruises.

  Note: Use of correct knots prevents slippage and possible accidents.
- Gin blocks permit light and medium weight objects to be lifted considerable distances with savings of time and energy.

f. **Dollies and hand trucks**

- Dollies can transport heavy objects along level surfaces and slight grades.
- Hand trucks can transport heavy objects over rough ground, up and down stairs, up and down steep grades, and over level surfaces.

g. **Excavating equipment**

- Round point shovels are used for general digging purposes.
- Square point shovels are used for cutting straight lines in grass sod, squaring corners of excavations, and helping to make tunnels under sidewalks, shrubs, driveways, or porches.
- Sharp shooter shovels are used to make tunnels under sidewalks, shrubs, driveways, porches, and footings.
- Power trenchers are used to dig narrow and comparatively shallow trenches.
- Backhoes are used to dig wide (average18″–24″) and deep (average 8′–10′) trenches

  Note: Backhoes are recommended for use in stony and hard soils.

  Caution: Power trenchers and backhoes should only be operated by experienced equipment operators.

h. **Cast iron pipe assembly tools**

- Neoprene gaskets are made in service weight for service weight soil pipe and fittings.
- Assembly tools are used to pull cast iron pipes and fittings together.
- Lead hammers are used to install fittings.

Information Sheet

4. **Safety precautions related to operating an air-acetylene torch outfit**

a. **Regulator**

- Keep regulator off when not in use.
- Be sure to turn adjustment screw completely off prior to start up.

  Note: Failure to turn screw off may burst the regulator, which can cause injury to the operator.

- Inspect all nuts and connections prior to using the regulators.
- Do not force connections of hoses and regulators.
- Use the proper regulator on the proper cylinder.
- Do not exceed recommended pressures.
- Have only skilled mechanics repair faulty regulators.

b. **Gauges**

- Keep glass protected from breaking.
- Replace any broken gauge glasses.
- Do not attempt to repair a defective gauge.

c. **Hoses**

- Test hoses for leaks by immersing in water at normal working pressure.

  Note: Leaky hoses should be properly repaired or replaced.

- Use only one type of gas in the hose.

  Note: A mixture of different gases in the hose could result in an explosion.

- Avoid dragging the hose on a greasy floor.
- Avoid circumstances where a hose can be rolled upon, kinked, burned, or subjected to falling objects or hot metals.
- Keep hose connections tight.
- Do not repair a hose with tape.
- Keep the hose properly rolled and stored when not in use.

  Note: Spring type hose reels are also available.

Information Sheet

d. **Torches**

- Keep all connections to the torch tight.

  Note: Test them accordingly.

- Any torch suspected of being faulty should be repaired by a competent service person.

- Avoid any contact with greasy or oily substances.

e. **Torch tips**

- Do not remove a tip from the torch when it is hot.

  Note: Allow it to cool first.

- Use the manufacturer's wrench to remove the torch tip.

  Note: Do not use plain pliers.

- Handle tips carefully.

  Note: Restrictions in the tip may cause back pressure and leakage.

Equipment
Unit 3-B

Job Sheet 1—Light and Adjust the Air-Acetylene Torch

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Proper safety precautions were taken	______
• Tools and equipment were used correctly	______
• Torch was properly lit and adjusted	______
• Task completed in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Air-acetylene torch outfit
- Acetylene tank valve wrench
- Soap and water
- Striker
- Safety glasses

B. Procedure

Note: Tank should be purged before regulator is installed.

☐ 1. Put on safety glasses.

☐ 2. Open tank valve 1/2 turn.

Note: Leave tank key on tank valve while using this equipment.

☐ 3. Check system for leaks with soap bubbles.

Caution: Never check for a gas leak with a flame.

☐ 4. Open torch valve 1/4 turn.

☐ 5. Strike striker immediately.

☐ 6. Upon ignition of flame, open torch valve another 1/2 turn.

Caution: If flame does not ignite immediately, shut off valve on handle. Delayed ignition could cause an explosion.

Job Sheet 1

☐ 7. Adjust flame so that inner blue cone is about 1 $^1/_2$" long.

Note: If there is an air gap between the inner blue cone and the torch tip, the regulator adjusting screw may need to be turned counterclockwise in order to decrease the pressure.

☐ 8. Extinguish by closing tank valve first.

☐ 9. Let the flame burn itself out.

☐ 10. Close torch handle valve.

☐ 11. Roll up hose.

☐ 12. Put away equipment.

Evaluator's Comments: ____

____

____

Equipment
Unit 3-B

Job Sheet 2—Set Up and Adjust the Builder's Level

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Level was set up and adjusted properly	______
• Task completed in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Instrument
- Tripod

B. Procedure

☐ 1. Grasp the two legs of the tripod that are nearest you and set the leg shoes in the ground about three feet apart.

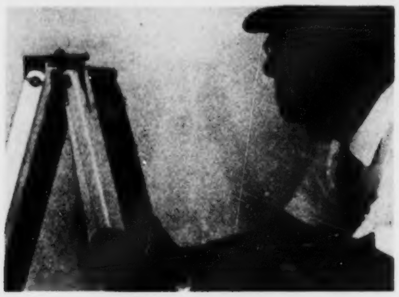
☐ 2. Swing third leg out to form a triangle.

Note: If the ground is not level, you may have to change the position of the tripod in order to keep the headplate level.

☐ 3. Tighten leg thumb nuts.

☐ 4. Check headplate to see if it is level. (Figure 1)

FIGURE 1

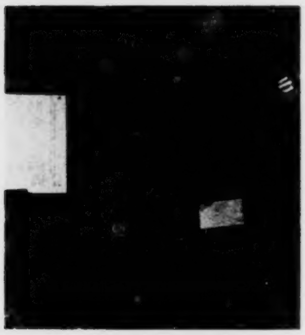


Job Sheet 2

☐ 5. Remove instrument from carrying case by lifting the level bar. (Figure 2)

Caution: Never grasp the telescope barrel while removing instrument from carrying case.

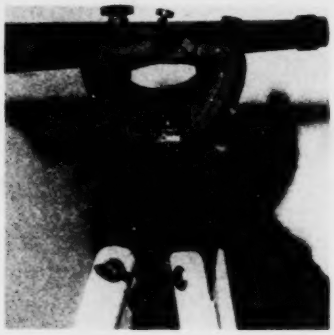
FIGURE 2



☐ 6. Attach instrument to head plate by screwing it down. (Figure 3)

Caution: Keep a firm grip on instrument until it is securely in position on tripod.

FIGURE 3



☐ 7. Remove dust cap from front lens.

Note: The dust cap should be kept in place when the instrument is not in use in order to protect the lens from dust or scratches.

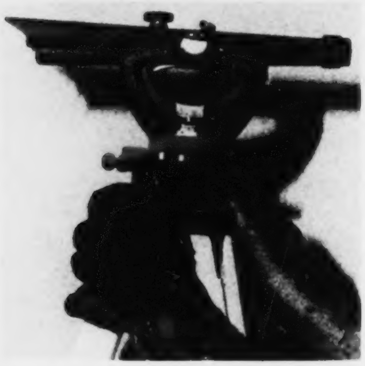
☐ 8. Attach sun shade to the instrument.

Job Sheet 2

☐ 9. Align telescope barrel directly over one pair of leveling screws. (Figure 4)

Note: The leveling screws will be used just as the name indicates, to level the instrument.

FIGURE 4



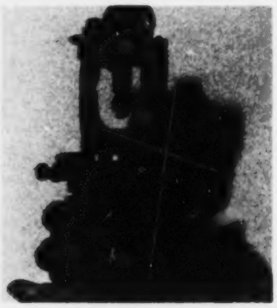
☐ 10. By rotating screws under the barrel, bring bubble to the center of the leveling tube.

Note: Move your thumbs in opposite directions.

☐ 11. Check bubble to see if it is centered.

☐ 12. Turn instrument clockwise through 90° to align with the other pair of leveling screws. (Figure 5)

FIGURE 5



☐ 13. Bring bubble to center of marks by rotating leveling screws.

☐ 14. Turn instrument clockwise through 90° to bring it parallel with first pair of leveling screws.

☐ 15. Center bubble again.

Job Sheet 2

☐ 16. Turn instrument clockwise through 90° to bring it parallel with second pair of leveling screws.

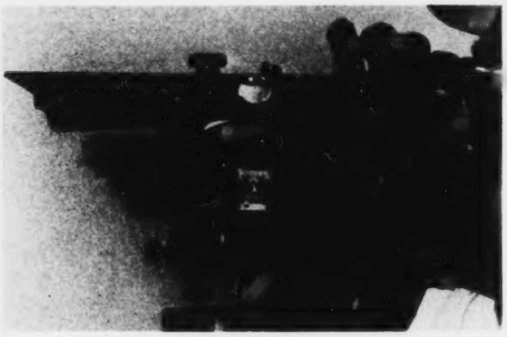
☐ 17. Center bubble again.

Note: Bubble should stay in center regardless of what direction the telescope is pointing.

☐ 18. Focus cross hairs so that they appear sharp and clear. (Figure 6)

Note: To focus the instrument, look through the eye piece and turn the eye-piece ring until the cross hairs become sharp or "clear."

FIGURE 6



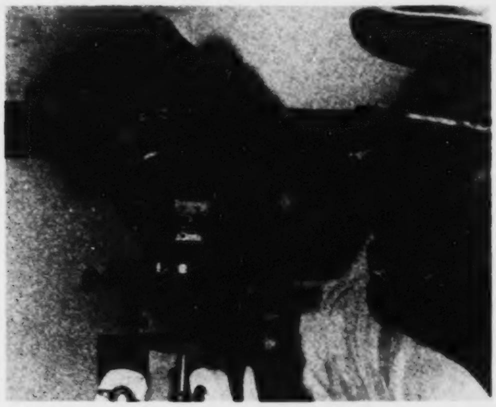
Note: Cross hairs should now be focused, but the target may not be in focus.

Job Sheet 2

☐ 19. By rotating the focusing screw, bring target into sharp focus. (Figure 7)

Note: When cross hairs and target are in sharp focus, you should be able to read a rod accurately.

FIGURE 7



☐ 20. Ask your instructor to check your work.

☐ 21. Reverse set up procedure to disassemble and put away instrument.

Evaluator's Comments: ____

____

____

Equipment
Unit 3-B

Job Sheet 3—Set Up an Inflatable Rubber Test Plug in a Pipe

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Test plug was properly set up	______
• Tools and equipment were used correctly	______
• Work was neat and completed in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Rubber test plug
- Tire pump
- Pipe
- Clean cloth
- Safety glasses

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Wipe the inside of the pipe with the cloth to remove any obstructions or objects which could damage the plug.

☐ 3. Connect the test plug to the pump hose.

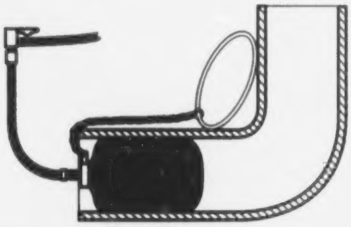
☐ 4. Insert the test plug into the pipe.

Note: No part of the plug should extend beyond the end of the pipe.

Job Sheet 3

☐ 5. Inflate the test plug until it is firm and tight in the pipe. (Figure 1)

FIGURE 1



Courtesy of Cherne Industries

☐ 6. Ask your instructor to inspect your work.

☐ 7. Clean up work area.

Evaluator's Comments: ______________________________

____

____

Equipment
Unit 3-B

Job Sheet 4—Set Up a Mechanical Test Plug in a Pipe

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Test plug was properly set up	______
• Tools and equipment were used correctly	______
• Work was neat and completed in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Test plug
- Pipe
- Oil can
- 12″ pipe wrench
- Clean cloth
- Safety glasses

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Turn the wing nut counterclockwise, loosening the test pump.

☐ 3. Lightly oil the threaded portion of the plug.

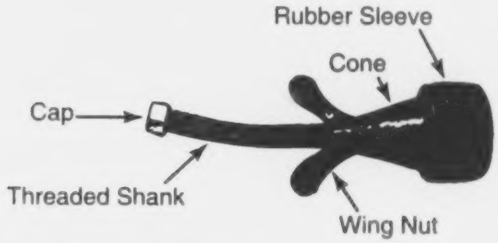
☐ 4. If the pipe end of the plug is not to be used to fill the system with water, tighten the cap with the 12″ wrench.

Note: Use pipe dope on the male threads to help ensure a sealed joint.

Job Sheet 4

☐ 5. Turn the wing nut clockwise until it is snug against the cone of the plug. (Figure 1)

FIGURE 1



Courtesy of Cherne Industries

☐ 6. Wipe the rubber ring and the inside of the pipe with a clean cloth to remove any sand or grit.

☐ 7. Insert the plug into the end of the pipe.

Note: Allow enough room for the wing nut to be tightened without its touching the pipe end.

☐ 8. Screw the wing nut clockwise, expanding the rubber ring against the inside circumference of the pipe.

Note: Keep the test plug straight in the pipe to assure a good sealing effect.

☐ 9. Ask your instructor to inspect your work.

☐ 10. Loosen the test plug and remove from pipe.

☐ 11. Clean up work area.

Evaluator's Comments: ______________________________

____

____

Equipment
Unit 3-B

Job Sheet 5—Set Up and Operate a Ratchet Lever Hoist

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Proper safety precautions were taken	______
• Hoist was properly set up and operated	______
• Tools and equipment were used correctly	______
• Work was completed in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Ratchet lever hoist
- Heavy object such as a large pipe or bathtub
- Rope, chain, and/or sling
- Safety glasses

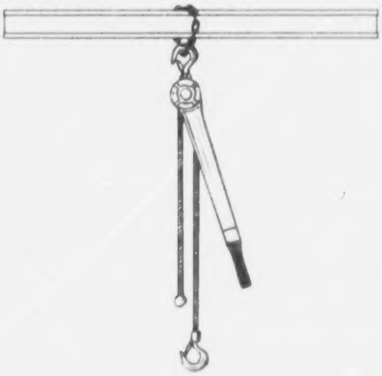
B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Secure upper hook of hoist to overhead beam. (Figure 1)

Note: A short length of chain is best for this operation.

FIGURE 1

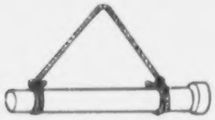


☐ 3. Run out enough cable to allow object to be lifted to the desired height.

Job Sheet 5

☐ 4. Secure object to be lifted with slings or rope. (Figure 2)

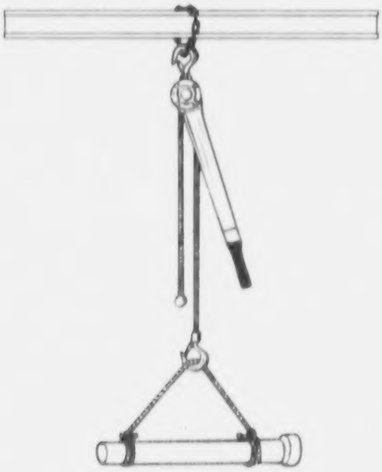
FIGURE 2



☐ 5. Attach lower hoist hook to sling and tighten cable with ratchet.

☐ 6. Lift object an inch off the floor and check all parts of the lifting assembly. (Figure 3)

FIGURE 3



☐ 7. Operate ratchet until object is lifted to the desired height.

☐ 8. Ask your instructor to inspect your work.

☐ 9. Turn ratchet to "reverse" and lower object to the floor.

☐ 10. Remove lower cable hook and sling.

☐ 11. Remove hoist and chain support.

☐ 12. Clean up work area.

Evaluator's Comments: ____________________

Blueprint Reading
Unit 1-C

Objective Sheet

Unit Objective

After completing this unit, the student should be able to identify the types of lines and blueprint symbols, read an architect's scale, and determine dimensions in a drawing using an architect's scale. The student should demonstrate these competencies by completing the assignment sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to blueprint reading with the correct definitions.
2. List types of architectural drawings.
3. Match lines from the alphabet of lines with their correct names.
4. Match floor plan and section drawing names with their correct symbols.
5. Identify plumbing, appliance, and structural symbols.
6. Match piping and fitting or valve names with their correct symbols.
7. List major items that should be included in a set of specifications.
8. Find specific information from a detailed specifications statement.
9. Select true statements about reading an architect's scale.
10. Read the architect's scale at $1/4'' = 1'$. (Assignment Sheet 1)
11. Read the architect's scale at $1/8'' = 1'$. (Assignment Sheet 2)
12. Read the architect's scale at $1'' = 20'$. (Assignment Sheet 3)
13. Read the architect's scale at $1'' = 50'$. (Assignment Sheet 4)
14. Determine dimensions on a drawing using an architect's scale. (Assignment Sheet 5)

Blueprint Reading
Unit 1-C

Information Sheet

1. **Terms and definitions**

    a. **Alphabet of lines**—Set of conventional symbols covering all the lines needed to depict an object as to size and shape

    b. **Architect's scale**—A rule divided into proportional feet and inches; a fraction of an inch is proportionally equal to one foot

    Examples: 1/8", 1/4", 3/8", 1/2", 3/4", 1 1/2", and 3" to the foot

    c. **Architectural drawings**—Step-by-step directions which are shown graphically

    Note: They are sometimes called construction drawings.

    d. **Blueprint**—A copy of the original detailed architectural or construction drawing

    e. **Building code**—Collection of laws listed in booklet form that apply to a given community, state, or nation

    f. **Detail view**—A drawing that gives complete detailed information for the construction of part of an object

    g. **Dimensions**—The arrangement of lines and symbols to indicate the actual size for constructing the object that is represented

    h. **Elevation view**—Drawings representing the front, sides, or rear face of a building or object; usually made as though the observer were looking straight at the object

    i. **Engineer's scale**—A rule divided into units of feet proportionally equal to one inch

    Examples: 10′, 20′, 30′, 40′ = one inch

    j. **Plan view**—Horizontal cut through a building showing the foundation, rooms, partitions, windows, doors, and stairs

    k. **Roof pitch**—Angle of roof designed to drain rain water; also adds to beauty of building

    l. **Scale drawing**—A drawing made to size either proportionally larger or smaller than the actual size of the object represented

    m. **Section view**—A drawing of an object that has been cut to show internal construction

    n. **Specifications**—A detailed set of written instructions which explains the drawing and the materials used, and becomes part of the legal contract

    o. **Symbol**—An arbitrary sign that has been standardized and is used to represent an object, quality, or method

    p. **Working drawing**—A technical drawing which includes all dimensions and procedures to guide workers in the construction of a building

Information Sheet

2. Types of architectural drawings

a. **Plot plan**—Characteristics include:

Note: The entrance to the building should be located at the bottom of the page.

- The location of the building on the lot

  Note: The plot plan sometimes shows legal descriptions of the building.

- Finished grade contours
- Property lines
- Available utilities
- Location of existing trees

  Note: Some plot plans also indicate new landscaping.

- Location of sewer pipe extension from house

b. **Foundation plan**—Characteristics include:

Note: The entrance to the building should be located at the bottom of the page.

- The location, size, and shape of footings, stemwalls, and piers
- Openings and clearance for crawl space under a conventional wood floor
- Entrance for underground utilities and services

c. **Floor plan**—Characteristics include:

Note: The entrance to the building should be located at the bottom of the page.

- Outside walls including the location and dimensions of all exterior openings
- Type of construction through the use of symbols
- The finish floor dimension
- The location of interior walls and partitions
- Direction a door is to swing
- Stairways and elevators
- Location of cabinets, built-ins, and plumbing fixtures

Information Sheet

d. **Elevation**—Characteristics include:

Note: Elevations show the exterior appearance of each side of the building. Typical elevations are front, left, right, rear, and section (optional).

- Grade line
- Floor heights
- Head and sill heights of windows, doors, and other openings in each story
- Roof line and pitch
- Cornice

e. **Detail**

Note: These drawings are used primarily to depict details of construction that are too small or not clearly shown on the plan or elevation drawings. They may be full size or to a larger scale than the plan elevation, and they may be a section view.

- Molding
- Mill work
- Ornamental iron
- Cabinets
- Built-ins
- Fireplace
- Stairs

  Note: Sections are used freely in these drawings.

- Mechanical drawing—Plumbing and heating

  Note: This is only occasionally shown on residential blueprints.

3. **Alphabet of lines**

a. **Object lines**—Show the main outline of the building including exterior walls, interior partitions, porches, patios, driveways, and interior walls; these lines should be prominent lines on a drawing.

Example: ————————

b. **Dimension lines**—Thin, unbroken lines on which building dimension are placed.

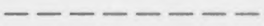
Example: ◄———————►

Information Sheet

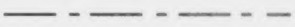
c. **Extension lines**—Extend, but do not touch, object lines and permit dimension lines to be drawn between them.

Example:

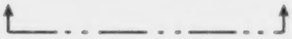
d. **Hidden lines**—Short dashes used to show lines that are not visible from the view shown.

Example: 

e. **Center lines**—A series of alternating short and long dashes used to designate the center of doors, windows, circles, and walls, and to provide a reference point for dimensioning.

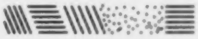
Example: 

f. **Cutting-plane lines**—Heavy lines consisting of a series of one long dash alternating with two short dashes; arrows at each end point away from the area that is cut away in a section drawing.

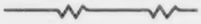
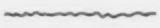
Example: 

g. **Section lines**—A series of lines or various shapes or symbols used to depict an area that is a cross section of the whole object.

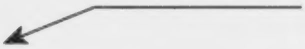
Note: Section lines also depict the type of material to be used in construction.

Example: 

h. **Break lines**—Used when an entire area cannot or should not be drawn.

Example: Long  Example: Short 

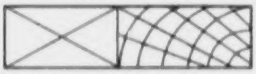
i. **Leaders**—Used to connect a note or dimension to a part of the object or building.

Example: 

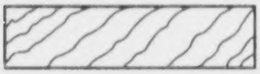
4. **Floor plan and section drawing symbols**

a. Floor plan

- Wood (rough)

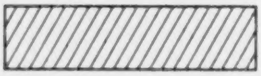


- Wood (finished)

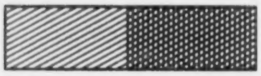


Information Sheet

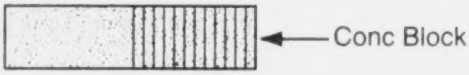
- Brick



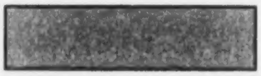
- Firebrick



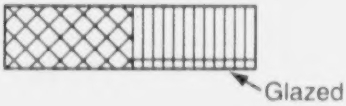
- Concrete



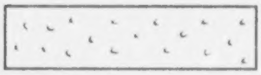
- Sand, plaster, cement, gypsum board



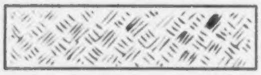
- Tile—hollow, terra cotta



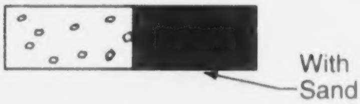
- Cinders



- Earth

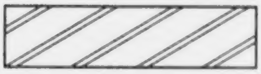


- Gravel

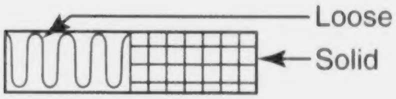


Information Sheet

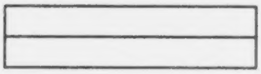
- Structural—steel or iron



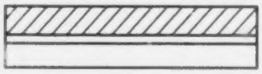
- Insulation



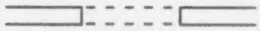
- Flashing, termite, barrier, water-proofing



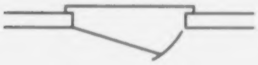
- Brick veneer



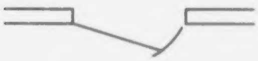
- Arch—Cased opening



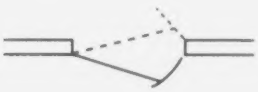
- Outside door



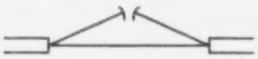
- Inside door



- Double-acting door

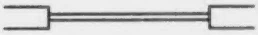


- Casement window

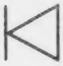


Information Sheet

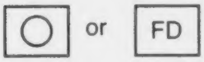
- Double-hung window



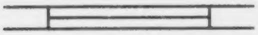
- Telephone jack



- Floor drain

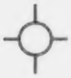


- Glass

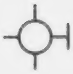


b. Electrical

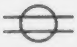
- Ceiling outlet



- Wall bracket outlet



- Duplex outlet



- Switch (single pole)

S_1

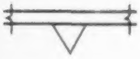
- Switch (3-way)

S_3

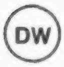
Information Sheet

c. Other symbols

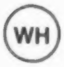
- Vacuum outlet



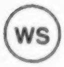
- Dry well



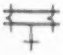
- Water heater



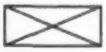
- Water softener



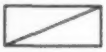
- Hose bib



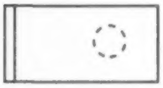
- Supply air duct



- Return air duct



- Heating unit

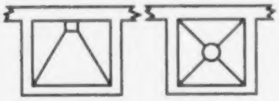


Information Sheet

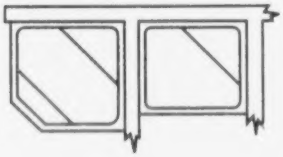
5. Plumbing, appliance, and structural symbols

a. Plumbing

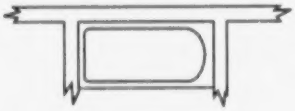
- Showers



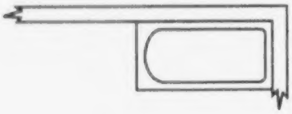
- Square corner and built-in square bathtub



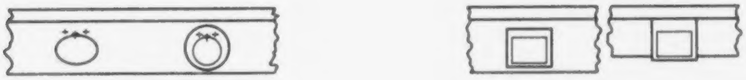
- Built-in bathtub (recessed)



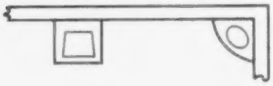
- Corner bathtub



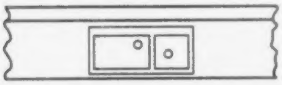
- Built-in lavatories



- Wall-hung and corner lavatory

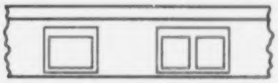


- Shallow bowl sink

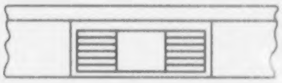


Information Sheet

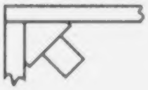
- Single bowl and double bowl sink



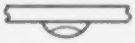
- Double drainboard sink with cabinet



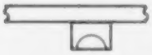
- Corner water closet



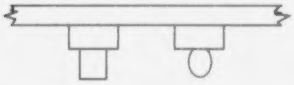
- Wall urinal



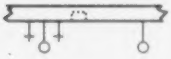
- Urinal



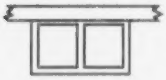
- Toilet stools or water closets



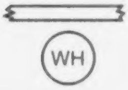
- Shower heads



- Laundry tubs



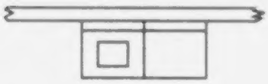
- Water heater



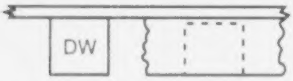
Information Sheet

b. **Appliance symbols**

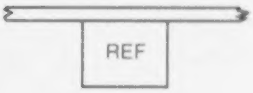
- Washer and dryer



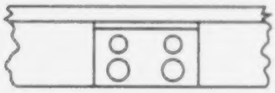
- Freestanding and built-in dishwashers



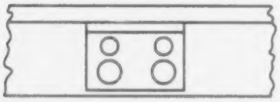
- Refrigerator or freezer



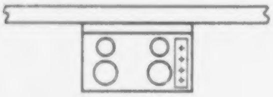
- Freestanding range



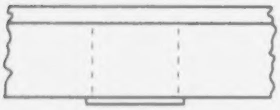
- Drop-in range



- Surface cook top



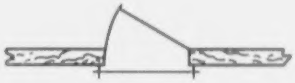
- Built-in oven



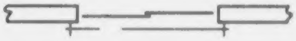
Information Sheet

c. Structural symbols

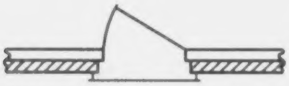
- Exterior door in wood frame wall



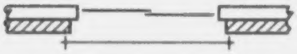
- Exterior sliding door in wood frame wall



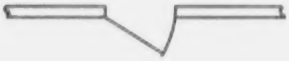
- Exterior door in masonry veneer wall



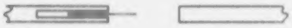
- Exterior sliding door in masonry veneer wall



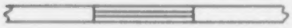
- Interior hinged door



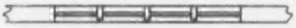
- Interior pocket door



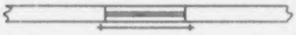
- Single window in frame wall



- Multiple windows in frame wall



- Double hung window in frame wall



Information Sheet

6. Piping and fitting or valve symbols

a. Piping symbols for plumbing

• Drain or waste above ground	————————
• Drain or waste below ground	—— —— ——
• Vent	— — — — —
• Storm drain	——— SD ———
• Cold water	—— – ——— – —
• Soft cold water	——— SW ———
• Hot water	—— - - ——— - - -
• Sprinkler main	——— S ———
• Sprinkler branch and head	——○——○——
• Gas	——— G — G ———
• Compressed air	——— A ———
• Vacuum	——— V ———
• Sewer—Cast iron	S-CI ————————
• Sewer—Clay tile	S-CT ————————
• Sewer—Plastic	S-P ————————

b. Piping symbols for heating

• High-pressure steam	——//———//——
• Medium-pressure steam	—/——/——/—
• Low-pressure steam	————————
• Fuel oil supply	——— FOS ———
• Hot water heating supply	——— HW ———
• Hot water heating return	——— HWR ———

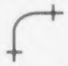
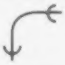
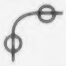
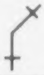
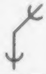
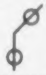
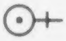
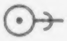
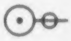
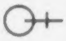
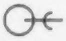
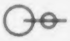
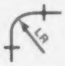
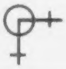
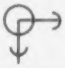
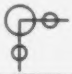
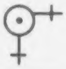
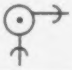
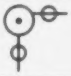
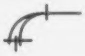
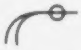
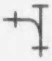
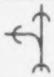
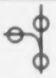
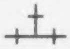
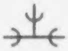
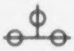
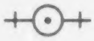
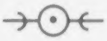
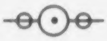
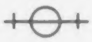
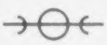
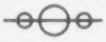
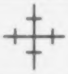
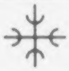
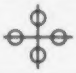
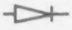
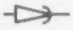
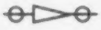
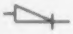
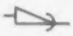
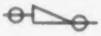
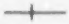
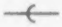
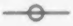
Information Sheet

c. Piping symbols for air conditioning

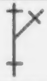
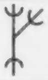
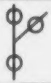
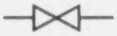
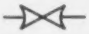
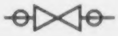
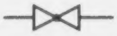
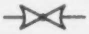
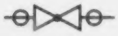
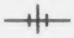
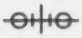
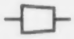
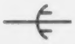
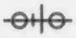
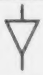
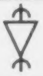
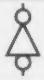
• Refrigerant liquid	——— RL ———
• Refrigerant discharge	——— RD ———
• Condenser water supply	——— C ———
• Condenser water return	——— CR ———
• Chilled water supply	——— CH ———
• Chilled water return	- - ——— - - ——
• Make-up water	——— MU ———
• Humidification line	— - ——— - —

Information Sheet

d. Fitting and valve symbols

Fitting or Valve	Type of Connection		
	Screwed	Bell and Spigot	Soldered or Cemented
Elbow—90°			
Elbow—45°			
Elbow—Turned Up			
Elbow—Turned Down			
Elbow—Long Radius			
Elbow With Side Inlet—Outlet Down			
Elbow With Side Inlet—Outlet Up			
Reducing Elbow			
Sanitary T			
T			
T—Outlet Up			
T—Outlet Down			
Cross			
Reducer—Concentric			
Reducer—Offset (Eccentric)			
Connector			

Information Sheet

Fitting or Valve	Type of Connection		
	Screwed	Bell and Spigot	Soldered or Cemented
Y or Wye			
Valve—Gate			
Valve—Globe			
Union			
Bushing			
Increaser			

7. **Major items included in a set of specifications**

   a. Manufacturer, style, size, and identification numbers of building materials

   b. Quality of building materials

   c. Standards and methods of construction

   d. Types of materials

   e. Quality and manner of workmanship

   f. All plumbing operations to be performed

   g. Reference to detailed working drawings

   h. Owner's name and address

   i. Contractor's name and address

   j. Location of new structure

   k. Completion date

   l. Contractor's bid

   m. Guarantees

   n. Method of payment

Information Sheet

8. Specification statement

Note: This is an example of a detailed specification statement for the plumbing contractor on a small residence.

Plumbing

This contractor shall install a complete plumbing system as per these plans and specifications.

All water piping shall be copper type "L."

All above ground drainage and vent piping shall be copper DWV.

Underground drainage pipe shall be cast iron.

All plumbing must adhere to the local plumbing code.

Building drain must be connected to city sewer lateral at curb.

Service pipe must be copper type "K" and connected at curb and meter.

All fixtures must be provided with shock arrestors on their water distribution pipes.

Outside sillcocks must be 12″ freeze-proof type.

Fixtures:

Kitchen Sink—Acme "Master Chef" #7940—White

Bath—Acme "Salt Wara" #8016—Blue

Lavatory—Acme "Hanwas" #122—Blue

Water Closet—Acme "Wasam" #16—Blue

Sink fitting—Groget "Klin" #8786

Lavatory fitting—Groget "Nogot" #88

Bath-Shower fitting—Groget "Long Wara" #32 124

The owner reserves the right to make changes by negotiating the contract.

Information Sheet

9. The architect's scale

a. Rules for reading a scale

- Check the title block to find the scale used on the drawing.
- Use the same scale to which the drawing was prepared.
- Lay the scale flat on the surface being measured.
- Double check all measurements.
- Measure from the center of one line to the center of the next line.
- Do not scale a drawing when dimensions are available.
- Read dimensions in the following order
  (1) Feet marked ′
  (2) Inches marked ″
  (3) Fractions of an inch

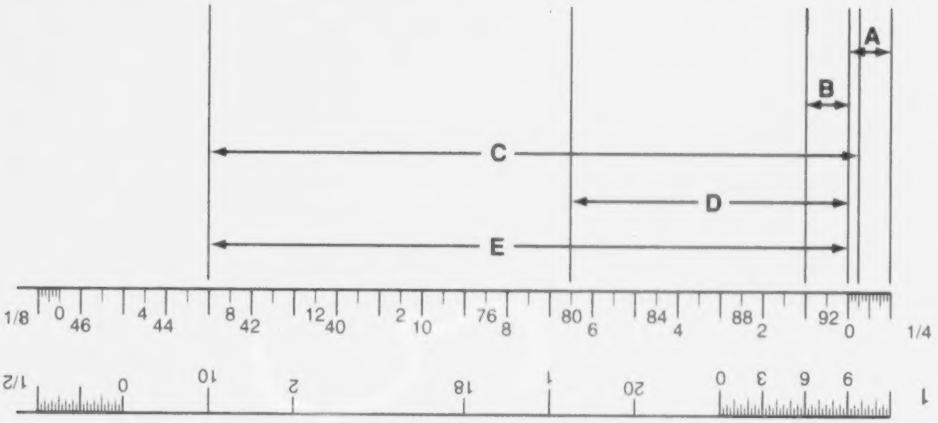
  Note: Some scales read from right to left, while others read from left to right.

Information Sheet

b. Commonly used scales for building plans

- 1/4″ = 1′
- 1/8″ = 1′ 0″
- 1/16″ = 1′ 0″
- 1″ = 20′ and 1″ = 50′ (common on plot plans)

Example: Practice reading the following 1/4″ scale (1/4″=1′)



A—1/4″ scale marked off in inches—1/4″ = 1′

B—1′

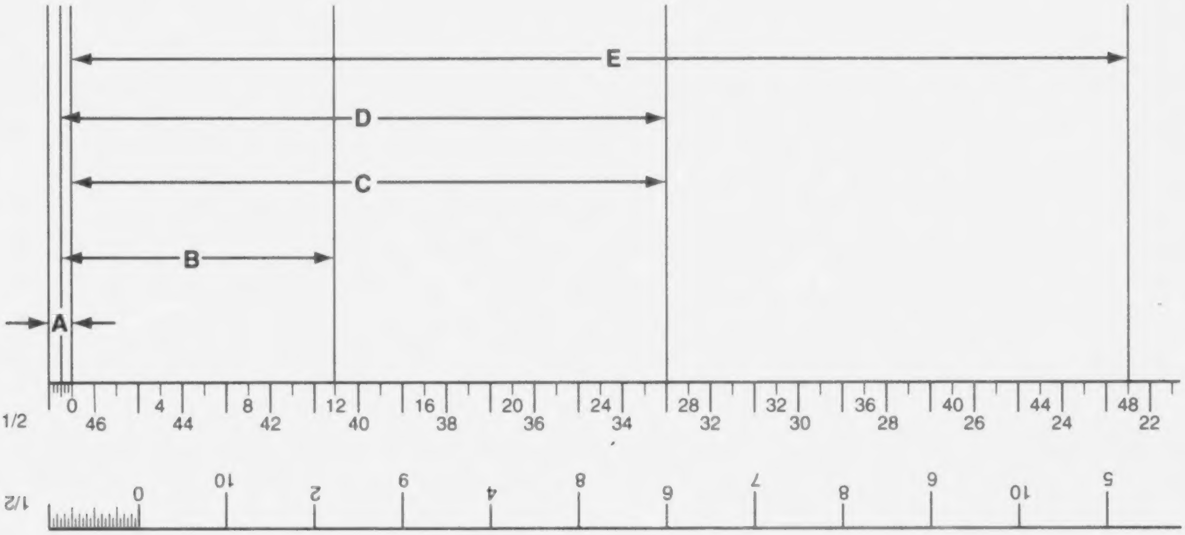
C—41′-3″

D—6′-6″

E—41′

Information Sheet

Example: Practice reading the following 1/8″ scale (1/8″=1′0″)



A—1/8″ scale marked off in inches—1/8″ = 1′

B—12′–6″

C—27′

D—27′–6″

E—48′

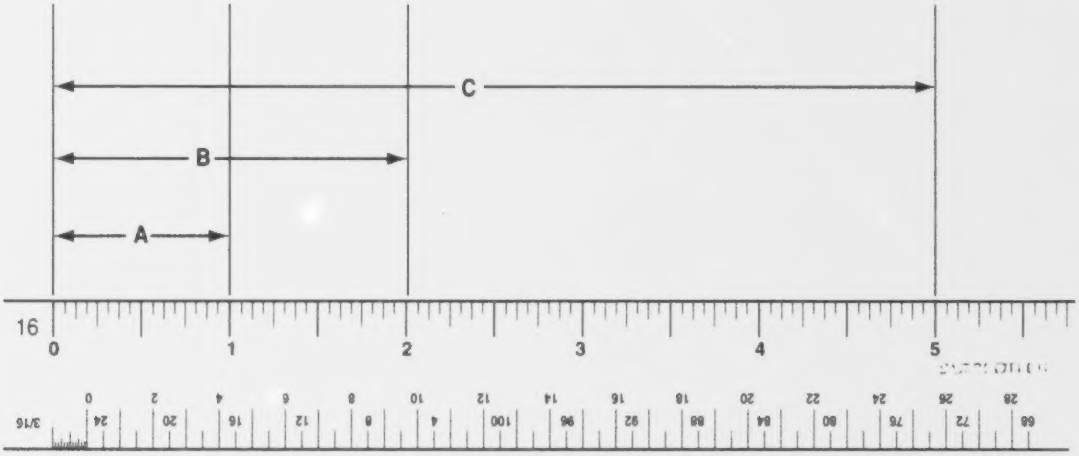
Information Sheet

c. Commonly used scales for plot plans

- 1″ = 20′
- 1″ = 50′

Note: The plan will specify 1″ = 20′, 1″ = 50′ or other suitable scale.

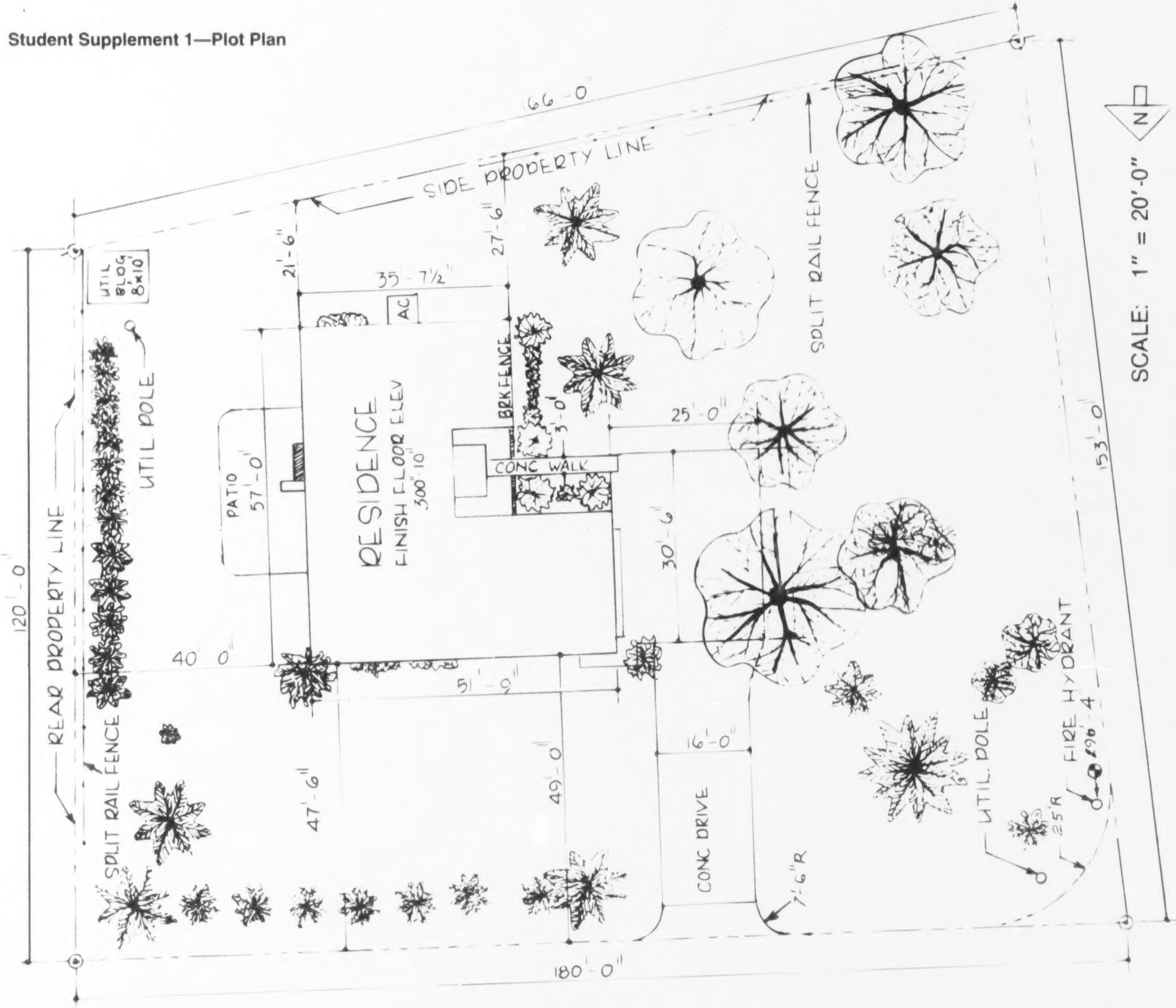
Example:



at 1″ = 20′	**at 1″ = 100′**
A—20′	A—100′
B—40′	B—200′
C—100′	C—1000′

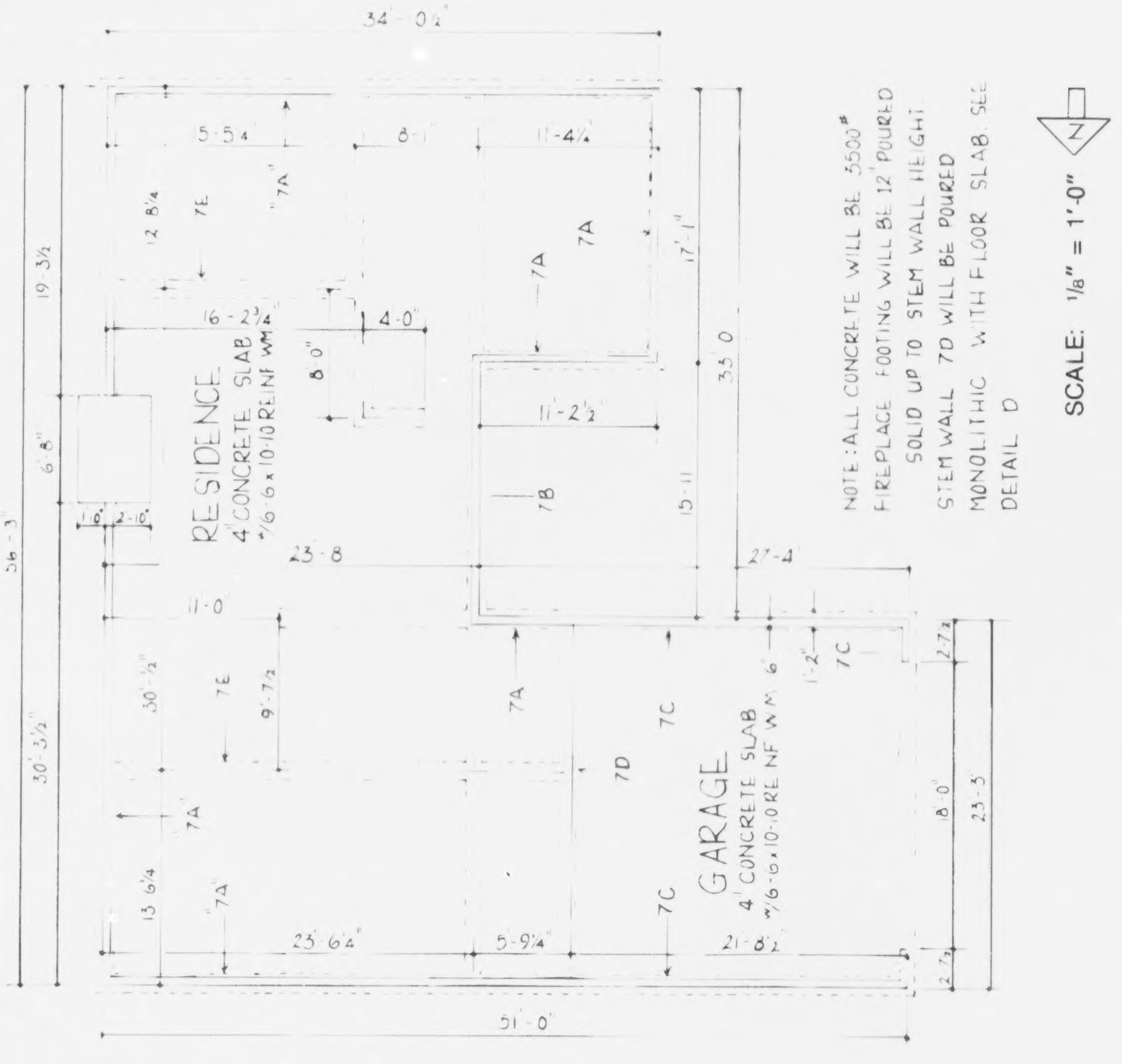
Blueprint Reading
Unit 1-C

Student Supplement 1—Plot Plan



Plot Plan

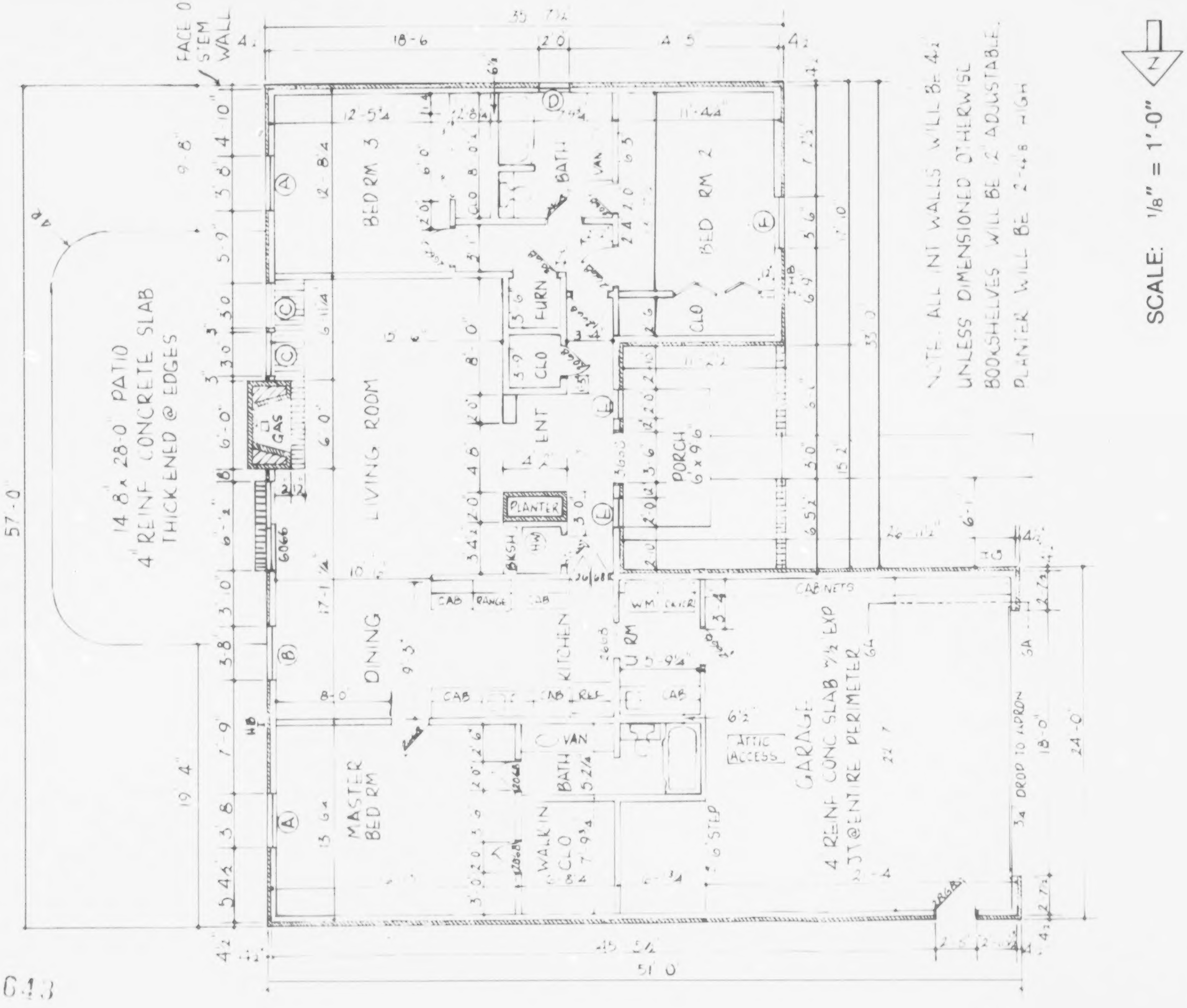
Student Supplement 2—Foundation Plan



SCALE: 1/8" = 1'-0"

Foundation Plan

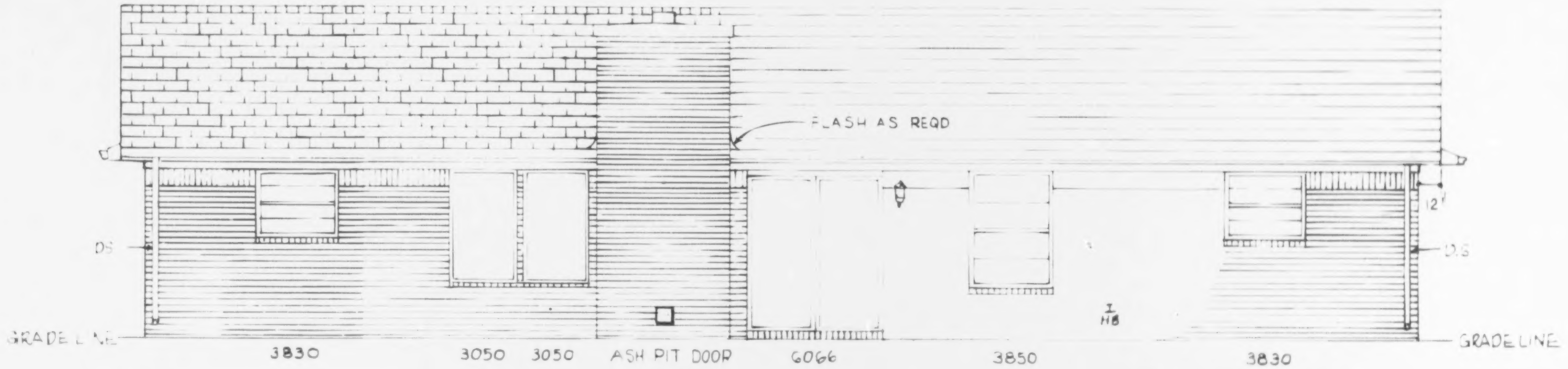
Student Supplement 3—Floor Plan



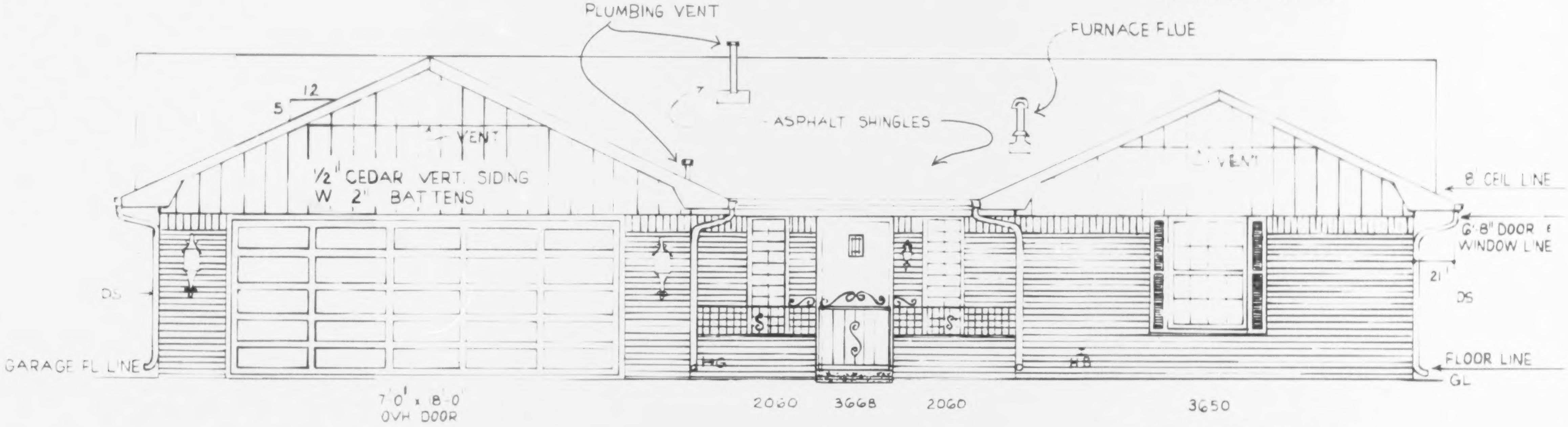
Floor Plan

Blueprint Reading
Unit 1-C

Student Supplement 4—Elevation Plan



East Elevation



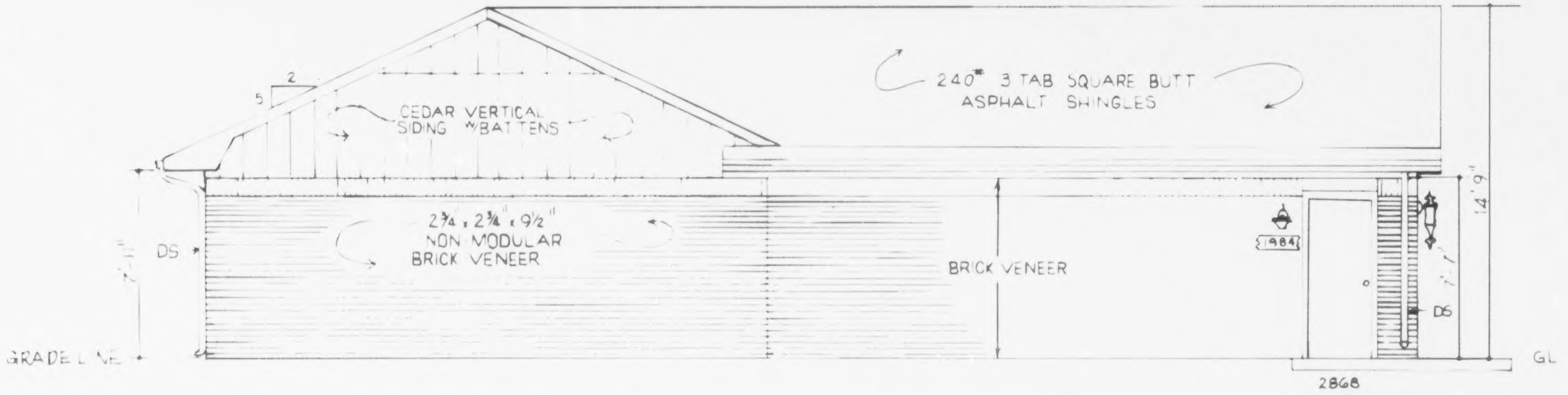
West Elevation

Elevation Plan

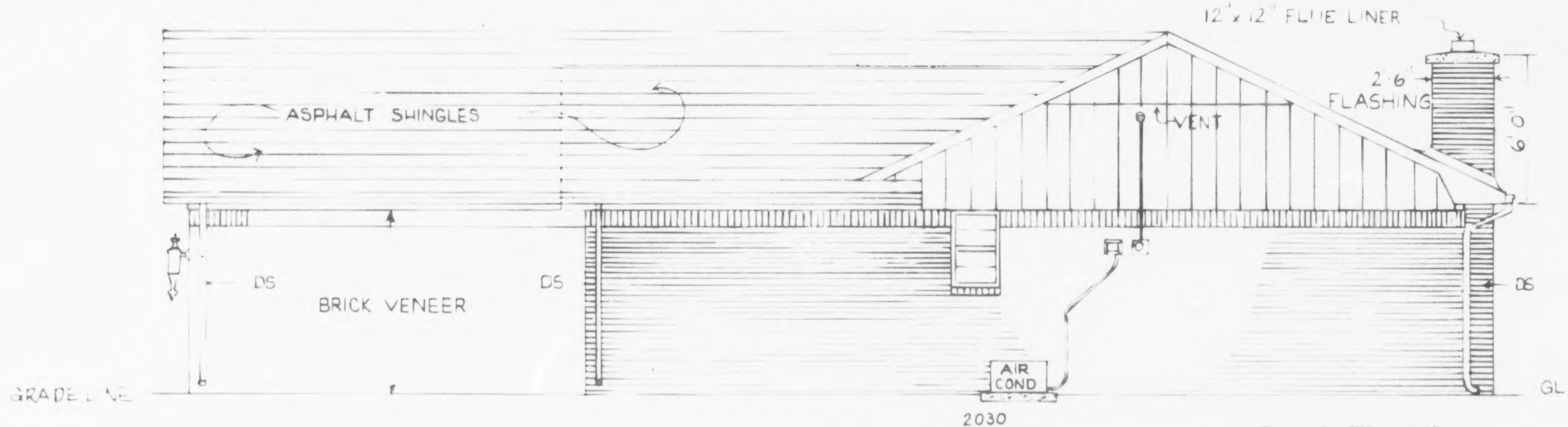
SCALE: 3/16" = 1'-0" N

Blueprint Reading
Unit 1-C

Student Supplement 5—Elevation Plan (Continued)


2
5
CEDAR VERTICAL SIDING w/BATTENS
240# 3 TAB SQUARE BUTT ASPHALT SHINGLES
2¾ x 2¾ x 9½" NON MODULAR BRICK VENEER
7'-1"
DS
BRICK VENEER
1984
7'-1"
DS
14'-9"
GRADE LINE
GL
2868

North Elevation



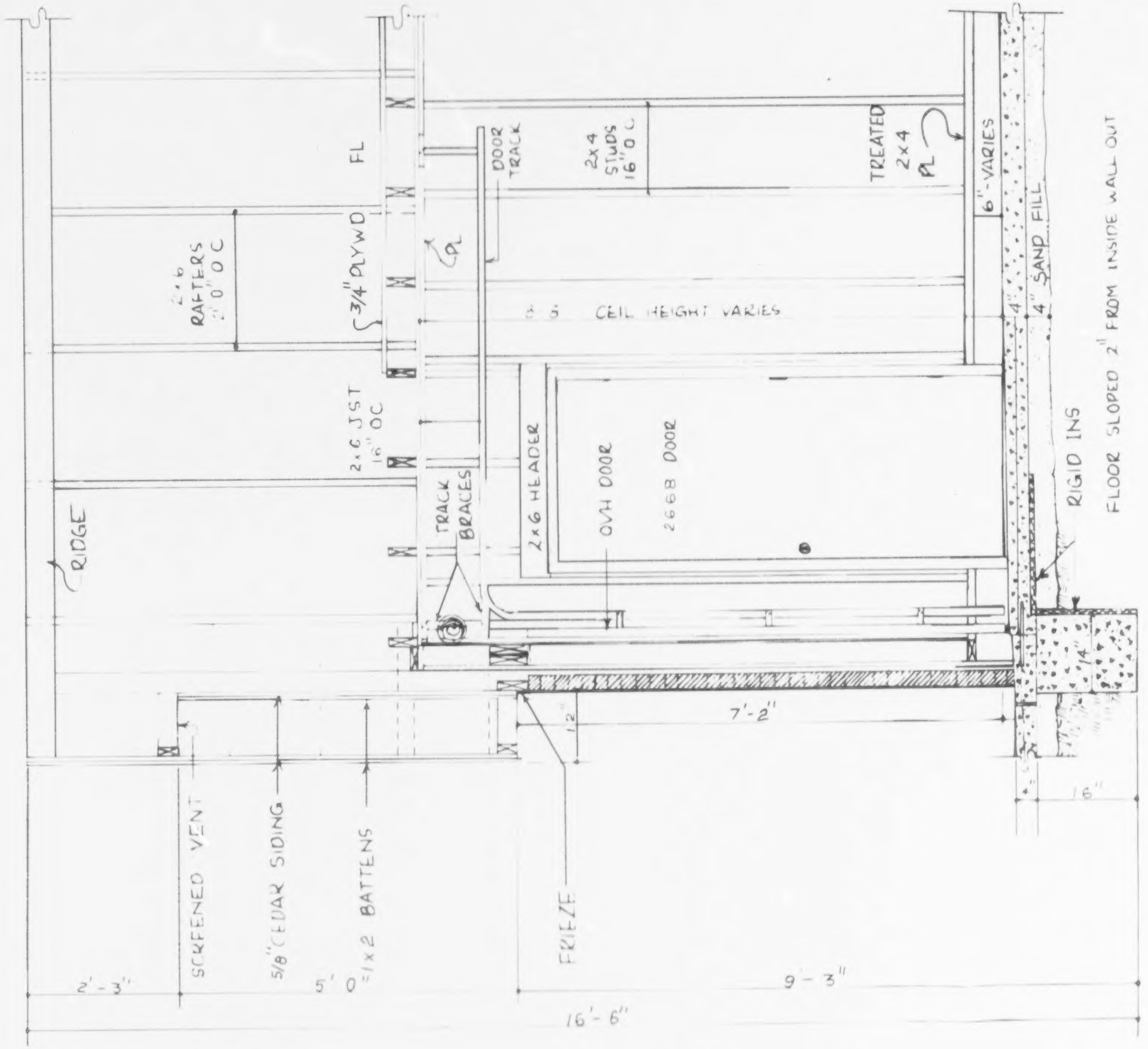
South Elevation

Elevation Plan
Continued

SCALE: $3/16'' = 1'\text{-}0''$

Blueprint Reading
Unit 1-C

Student Supplement 6—Section Drawing



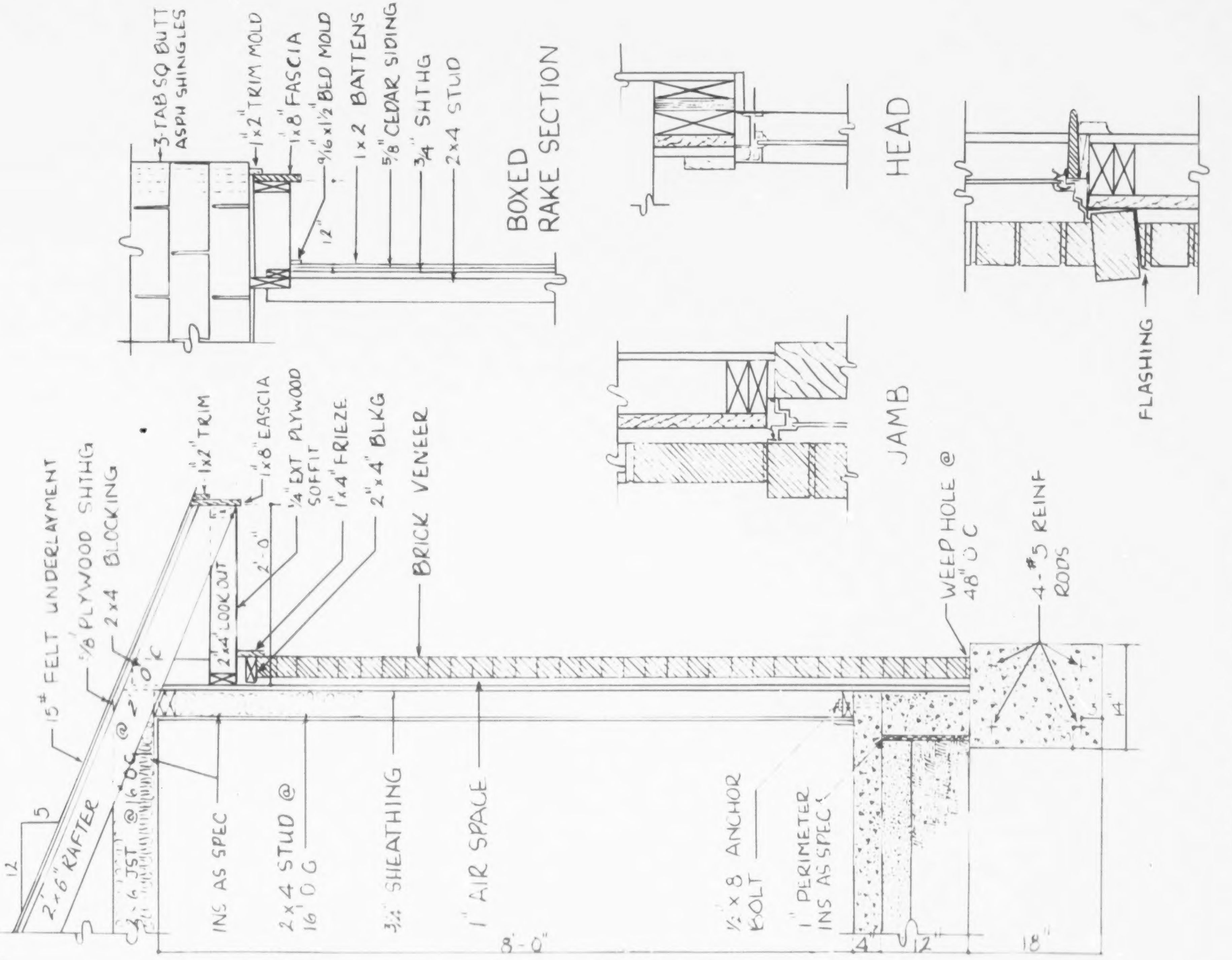
Section AA

SCALE: 1/2" = 1'-0"

Section Drawing

Blueprint Reading
Unit 1-C

Student Supplement 7—Details (Cornice and Windows)



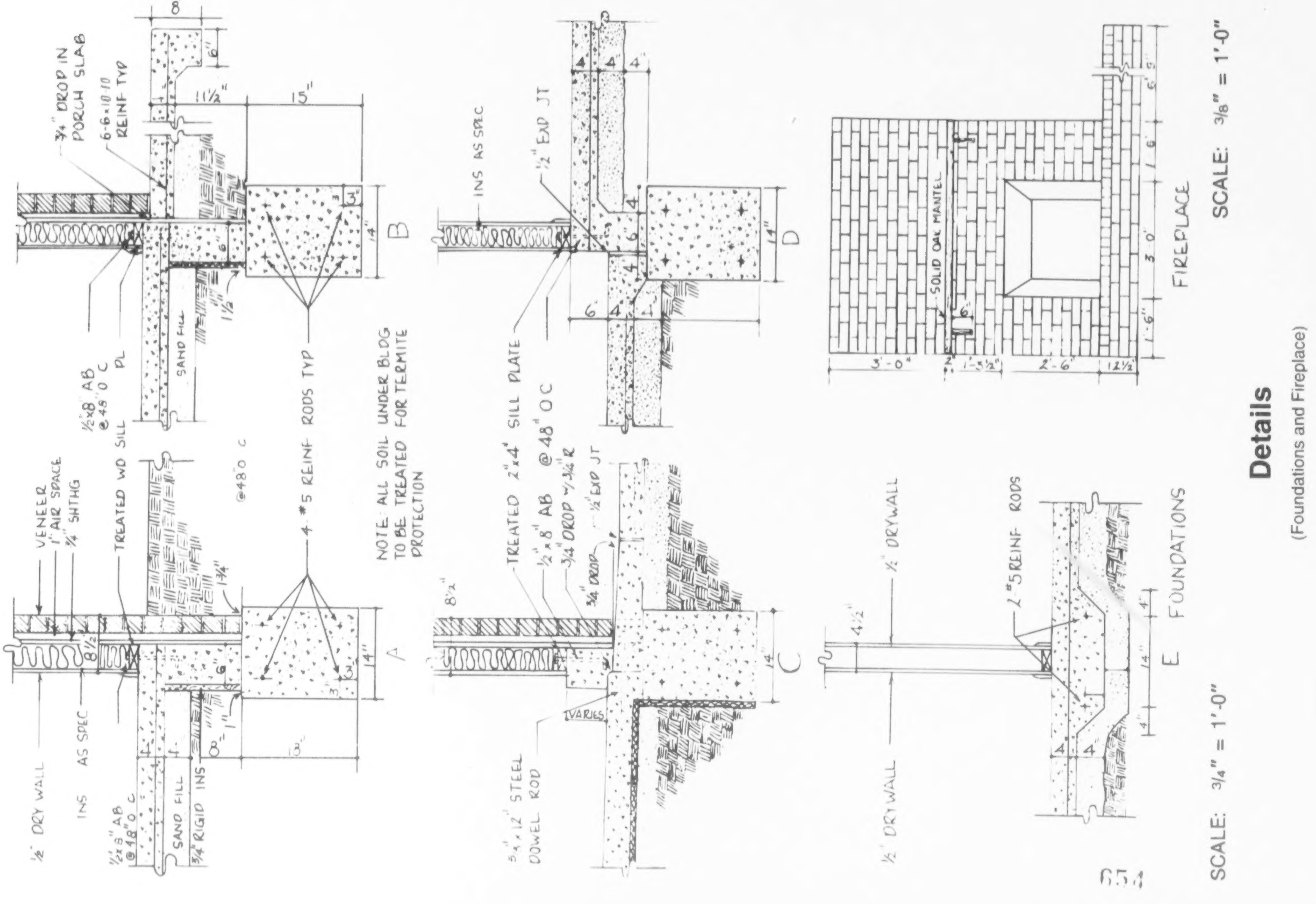
SCALE: 1 1/2" = 1'-0"

SCALE: 3/4" = 1'-0"

Details
(Cornice and Window)

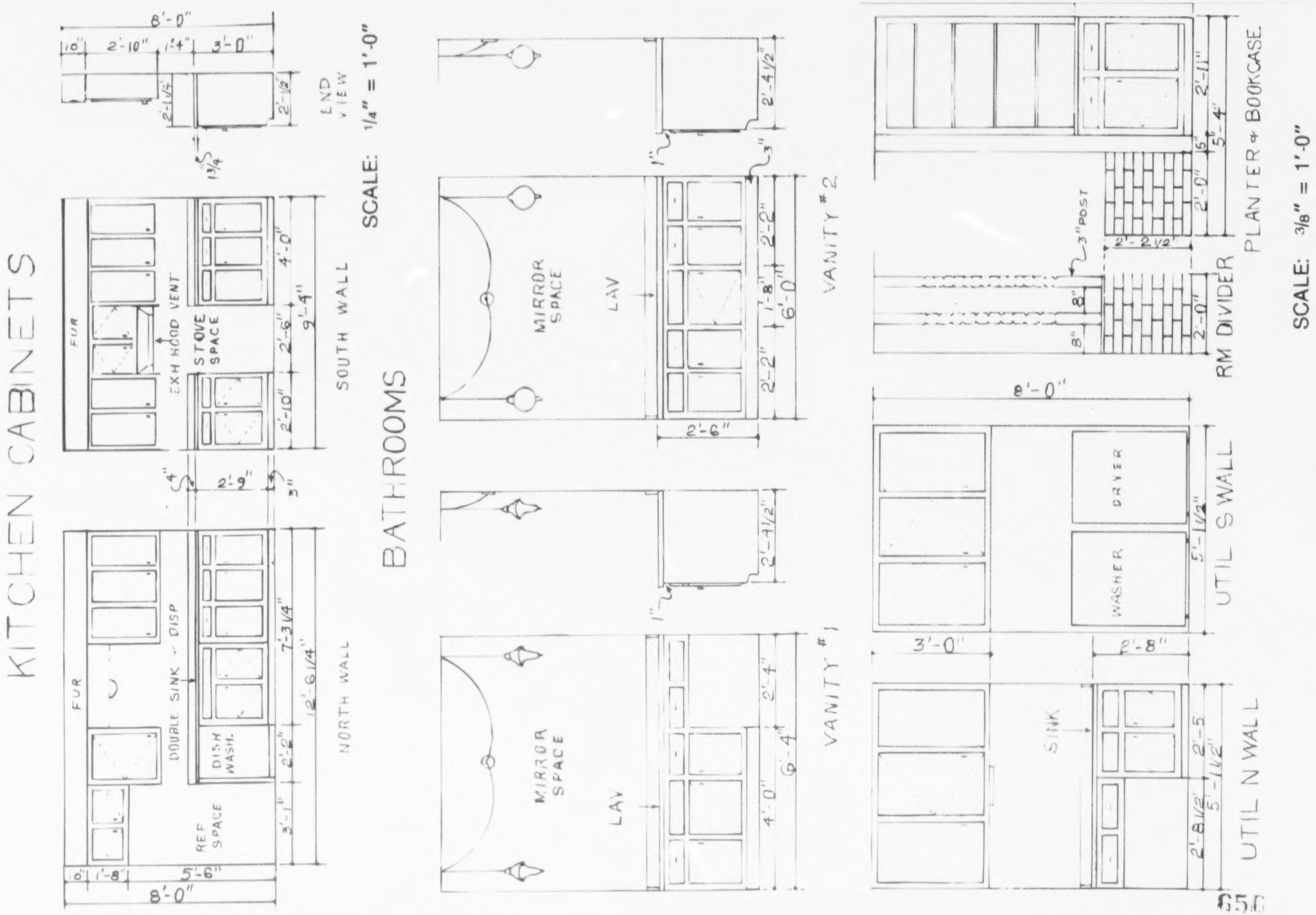
Blueprint Reading
Unit 1-C

Student Supplement 8—Details (Foundations and Fireplace)



Blueprint Reading
Unit 1-C

Student Supplement 9—Details (Kitchen, Bathrooms, and Other)



Details
(Kitchen, Bathrooms, and other)

Blueprint Reading
Unit 1-C

Student Supplement 10—Schedules

FINISH SCHEDULES
ROOM FINISHES

ROOMS	FLOOR					CEILING					WALL				BASE				TRIM				REMARKS
	CARPET	CERAMIC TILE	RUBBER TILE	CONCRETE		ACOUSTIC TEXT	DRY WALL	PAINT	CERAMIC TALE		DRYWALL	PAINT	WALL PAPER	CERAMIC TILE	WOOD	RUBBER	CERAMIC TILE	STAIN		WOOD	STAIN	PAINT	
ENTRY		✓				✓					✓	✓	✓		✓			✓		✓	✓		See owner for all painting
HALL	✓					✓					✓	✓			✓			✓		✓	✓		
BEDROOM 1	✓					✓					✓	✓	✓		✓			✓		✓	✓		See owner for grade of carpet
BEDROOM 2	✓					✓					✓	✓			✓			✓		✓	✓		See owner for grade of carpet
BEDROOM 3	✓					✓					✓	✓			✓			✓		✓	✓		See owner for grade of carpet
BATH 1	✓	✓				✓			✓		✓	✓	✓	✓	✓			✓		✓	✓		Wall paper three walls around vanity
BATH 2		✓				✓			✓		✓	✓	✓	✓			✓			✓	✓		Water seal tile Wall paper w wall
UTIL + CLOSETS	✓	✓ ✓					✓	✓			✓ ✓	✓			✓			✓		✓ ✓	✓	✓	Use off-white flat/latex
KITCHEN			✓			✓					✓	✓				✓				✓	✓		
DINING	✓					✓					✓	✓	✓		✓			✓		✓	✓		
LIVING	✓					✓					✓	✓			✓			✓		✓	✓		see owner for carpet
GARAGE				✓			✓	✓						✓		✓				✓	✓		

DOOR SCHEDULE

DOOR	WIDTH	HEIGHT	THICK-NESS	MATERIAL	TYPE	STORM DOOR	QUAN-TITY	THRESH-OLD	REMARKS	MANUFACTURER
2068	2'-8"	6'-8"	1 3/8"	Wood-Ash	Hollow-core	No	5	None	oil stain	L.B.J. Door, Inc.
2468	2'-4"	6'-8"	1 3/8"	Wood-Ash	Hollow core	No	1	None	Oil stain	L.B.J. Door Inc.
2668	2'-6"	6'-8"	1"	Wood-Ash	cafe	No	1 pr.	None	Oil stain	L.B.J. Door Inc
2668	2'-6"	6'-8"	1 3/8"	Wood-Ash	Sliding Pocket	No	1	None	Oil Stain	L.B.J. Door Inc
2668	2'-6"	6'-8"	1 3/8"	Wood-Ash	Hollow core	1 screen	6	1 Alum.	Screen door in garage	L.B.J. Door Inc
2868	2'-6"	6'-8"	1 3/4"	Metal Clad	Fire proof	Yes	1	Alum.	Paint	L.B.J. Door Inc
3068	3'-0"	6'-8"	1 3/4"	Wood-Ash	Solid Core	No	1	None	Oil stain	L.B.J. Door Inc
3688	3'-6"	6'-8"	1 3/4"	Wood-Ash	Solid Core	YES	1	Alum.	Marine Varnish	L.B.J. Door Inc
6066	6'-0"	6'-6"	1/2"	Glass+Metal	Sliding	Yes	1 pr.	Alum	Sliding screen	L.B.J. Door Inc
6068	6'-0"	6'-8"	1 1/4"	Wood-Ash	Bi Fold	No	25 sets	None	Oil stain	L.B.J. Boor Inc
1956	1'-9"	5'-6"	1/2"	Glass & Metal	Slid to sleeve door	No	25 sets	None	Frost & glass	L.B.J. Door Inc.

WINDOW SCHEDULE

SYMBOL	WIDTH	HEIGHT	MATERIAL	TYPE	SCREEN STORM	QUANTITY	REMARKS	MANUFACTURER	CATALOG NUMBER
A	3'-8"	3'-0"	Aluminum	Double Hung	Yes	2	4 Lites 4 High	LBJ Window Co	141 PW
B	3'-8"	5'-0"	Aluminum	Double Hung	Yes	1	4 Lites 4 High	LBJ	145 PW
C	3'-0"	5'-0"	Aluminum	Stationary	STORM ONLY	2	Single Lite	H & J Glass Co.	59 PY
D	2'-0"	3'-0"	Aluminum	Double Hung	Yes	1	4 Lites 4 High	LBJ	142 PW
E	2'-0"	6'-0"	Aluminum	Stationary	STORM ONLY	2	20 Lites	H & J Glass Co	37 TS
F	3'-6"	5'-0"	Aluminum	Double Hung	Yes	1	16 LITES 4 High	LBJ Window Co	147 PW

HEADER SCHEDULE

HEADER SIZE	EXTERIOR		INTERIOR	
	26' + Under	26' to 32'	26' + Under	26' to 32'
2-2x4	3'-6"	3'-0"	Use 2-2x6	
2-2x6	6'-6"	6'-0"	4'-0"	3'-0"
2-2x8	8'-6"	8'-0"	5'-6"	5'-0"
2-2x10	11'-0"	10'-0"	7'-0"	6'-6"
2-2x12	13'-6"	12'-0"	8'-6"	8'-0"

Schedules

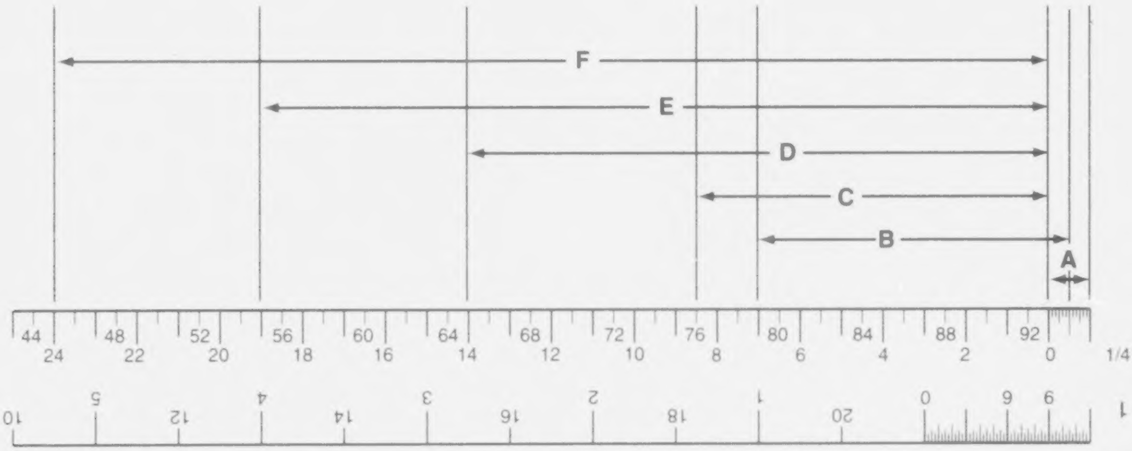
Blueprint Reading
Unit 1-C

Assignment Sheet 1—Read the Architect's Scale at 1/4" = 1'

Name ______________________ Overall Rating ____________

Evaluation Criteria	Rating
• Directions are followed	______
• Readings are accurate	______
• Assignment is neat and completed on time	______

Directions: Read the measurements shown below at the 1/4" scale by reading the distance from "0" at the right to the points on the scale indicated with letters. Write your answers on the blanks provided below.



1. A = ______________________

2. B = ______________________

3. C = ______________________

4. D = ______________________

5. E = ______________________

6. F = ______________________

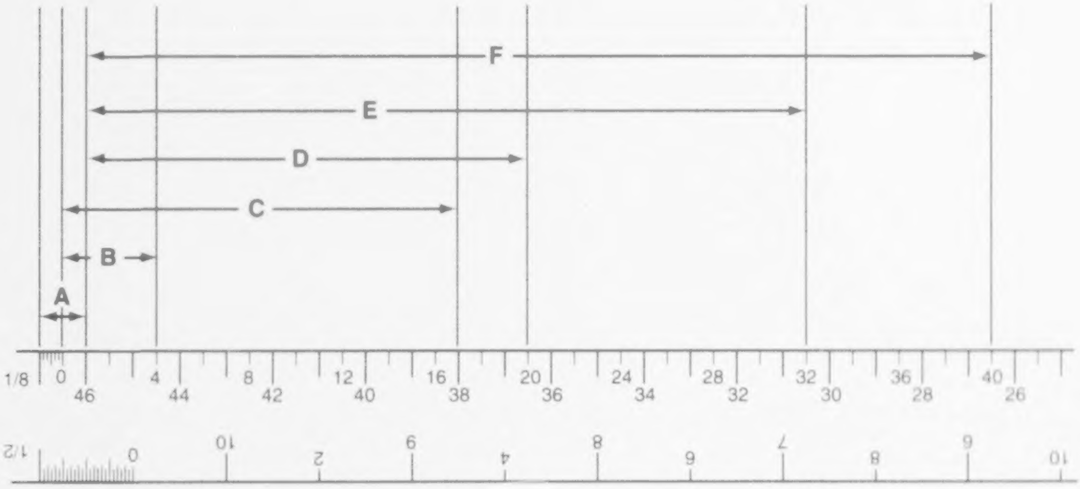
Blueprint Reading
Unit 1-C

Assignment Sheet 2—Read the Architect's Scale at 1/8" = 1'

Name ______________________ Overall Rating ____________

Evaluation Criteria	Rating
• Directions are followed	______
• Readings are accurate	______
• Assignment is neat and completed on time	______

Directions: Read the measurements shown below at the 1/8" scale by reading the distance from "0" at the left to the points on the scale indicated with letters. Write your answers on the blanks provided below.



1. A = ______________________

2. B = ______________________

3. C = ______________________

4. D = ______________________

5. E = ______________________

6. F = ______________________

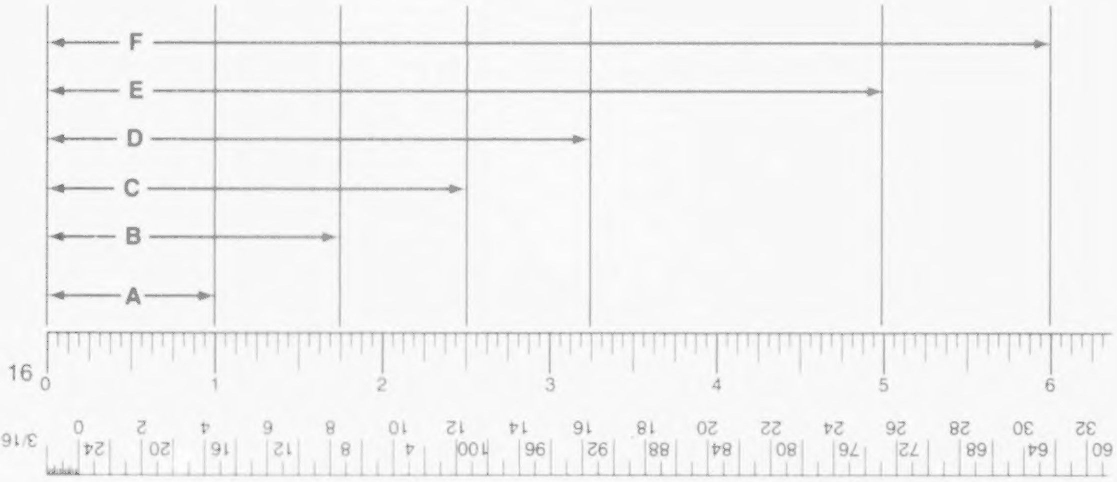
Blueprint Reading
Unit 1-C

Assignment Sheet 3—Read the Architect's Scale at 1″ = 20′

Name ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Directions are followed	________
• Readings are accurate	________
• Assignment is neat and completed on time	________

Directions: Read the measurements shown below at the 1″ = 20′ scale by reading the distance from "0" at the left to the points on the scale indicated with letters. Write your answers on the blanks provided below.



1. A = ______________________

2. B = ______________________

3. C = ______________________

4. D = ______________________

5. E = ______________________

6. F = ______________________

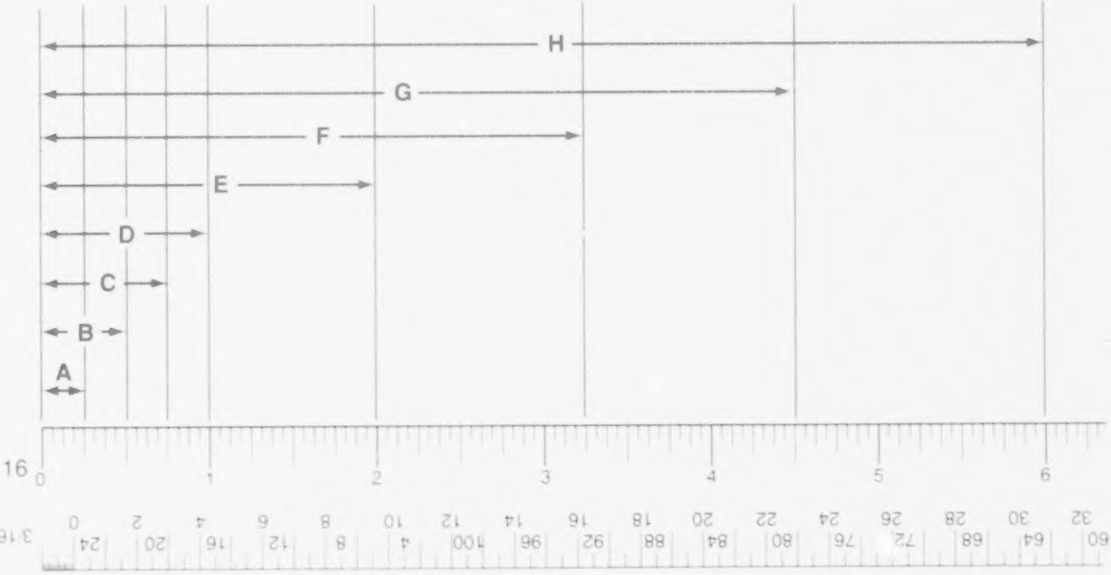
Blueprint Reading
Unit 1-C

Assignment Sheet 4—Read the Architect's Scale at 1″ = 50′

Name ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Directions are followed	______
• Readings are accurate	______
• Assignment is neat and completed on time	______

Directions: Read the measurements shown below at the 1″ = 50′ scale by reading the distance from "0" at the left to the points on the scale indicated with letters. Write your answers on the blanks provided below.



1. A = ______________

2. B = ______________

3. C = ______________

4. D = ______________

5. E = ______________

6. F = ______________

7. G = ______________

8. H = ______________

Blueprint Reading
Unit 1-C

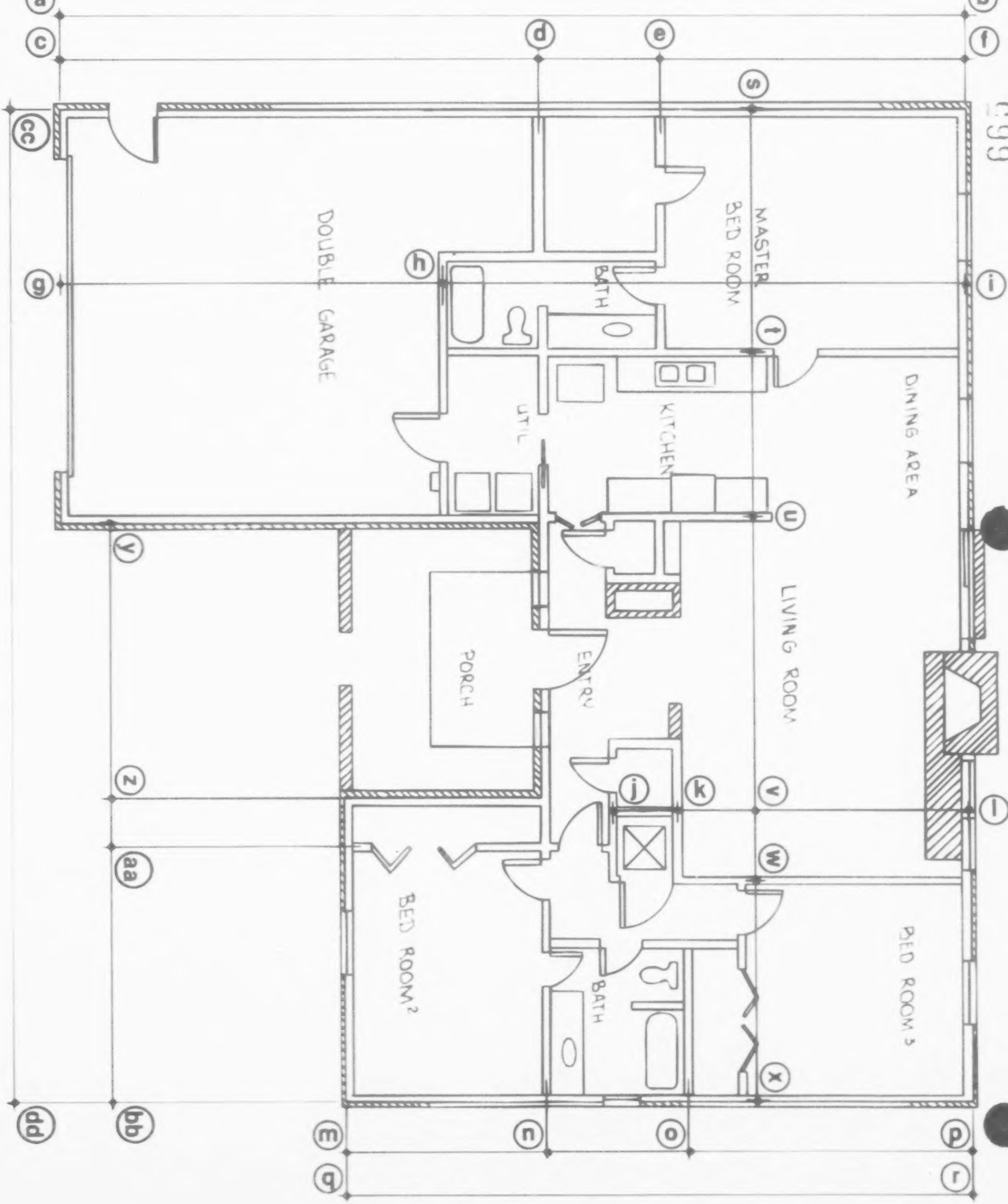
Assignment Sheet 5—Determine Dimensions on a Drawing Using an Architect's Scale

Name ______________________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Directions are followed	______
• Dimensions are accurate	______
• Assignment is neat and completed on time	______

Directions: Use the architect's scale at 1/8″ = 1′ to determine the dimensions on the drawing on the next page. As you are working, write your answers on the dimension lines of the drawing. Check all answers and then transfer your answers to the blanks provided on the following page. Also answer the questions on the answer page.

Assignment Sheet 5



Assignment Sheet 5

Answer blanks for dimensions.

1. a–b = ____________________
2. c–d = ____________________
3. d–e = ____________________
4. e–f = ____________________
5. g–h = ____________________
6. h–i = ____________________
7. j–k = ____________________
8. k–l = ____________________
9. m–n = ____________________
10. n–o = ____________________
11. o–p = ____________________
12. q–r = ____________________
13. s–t = ____________________
14. t–u = ____________________
15. u–v = ____________________
16. v–w = ____________________
17. w–x = ____________________
18. y–z = ____________________
19. z–aa = ____________________
20. aa–bb = ____________________
21. cc–dd = ____________________

22. What is the distance from the east wall to the middle of the kitchen sink?

____

23. What is the distance from the north wall to the north edge of the kitchen sink?

____

Sketches and Diagrams for Plumbers
Unit 2-C

Objective Sheet

Unit Objective

After completing this unit, the student should be able to develop plan and isometric sketches. The student should demonstrate these competencies by completing the assignment sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

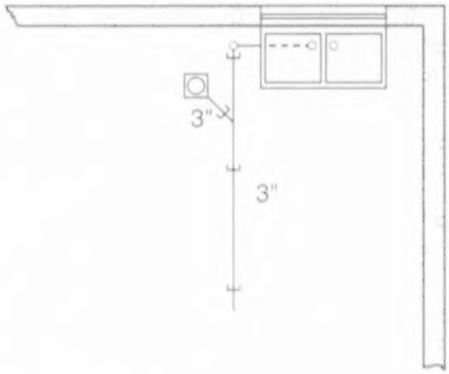
1. Select true statements concerning characteristics of a plan view sketch.
2. Select true statements concerning characteristics of a riser diagram.
3. Select true statements concerning characteristics of an isometric sketch.
4. Develop three types of sketches of a drainage system in a basement floor. (Assignment Sheet 1)
5. Develop an isometric sketch of a drainage system. (Assignment Sheet 2)

Sketches and Diagrams for Plumbers
Unit 2-C

Information Sheet

1. **Characteristics of a plan view sketch**

   a. Shows the structure as viewed from directly above



   b. Does not show pitch of pipe

   c. Can be used to determine:

   - Length of pipe
   - Location and types of fittings
   - Location of floor drains
   - Location of clean-outs
   - Direction of flow
   - Labor estimates

   d. Can serve as a record after the floor has been poured

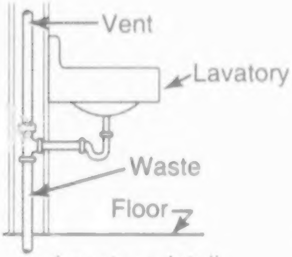
   e. Should show all floor drainage, including storm drainage and foundation drainage

Information Sheet

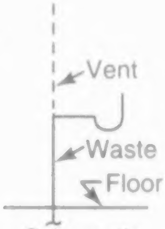
2. Characteristics of a riser diagram

a. Sectional view (schematic) through a building showing the piping system or part of the system

b. Two-dimensional representations

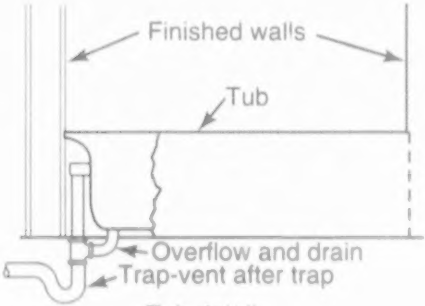


Lavatory detail

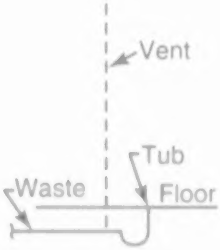


Schematic

c. Valuable in determining code and inspection requirements



Tub detail



Schematic

3. Characteristics of an isometric sketch

a. Isometric sketches are three-dimensional representations.

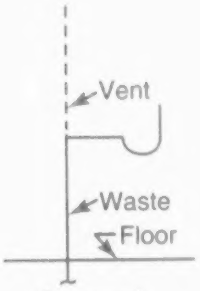
b. Isometrics combine plan and elevation views in one drawing.

c. Scaled isometric views help to determine an accurate materials list.

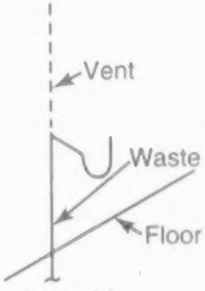
d. Pipes that are vertical on a plan or elevation view, such as soil, water, and vent stacks, remain vertical in an isometric drawing.

Information Sheet

e. Pipes that are horizontal on a plan or elevation view are shown at a 30° angle in an isometric drawing.

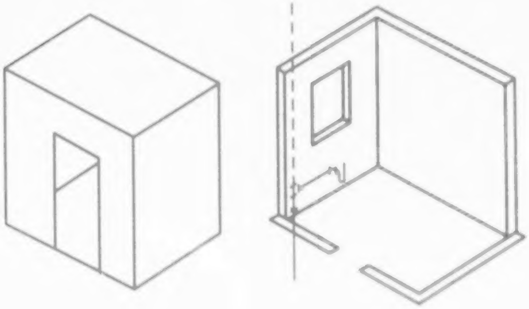


Schematic

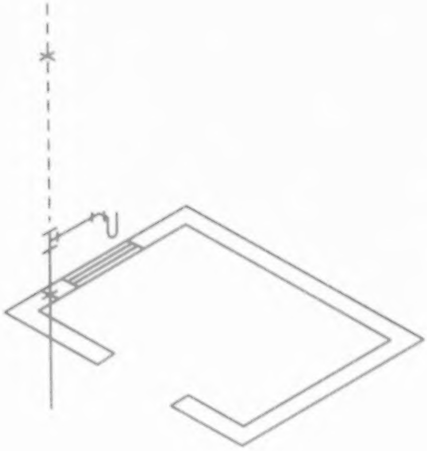


Isometric

f. This house, in outline form, would show the drainage system as horizontal lines, 30°; vertical lines, 90°.

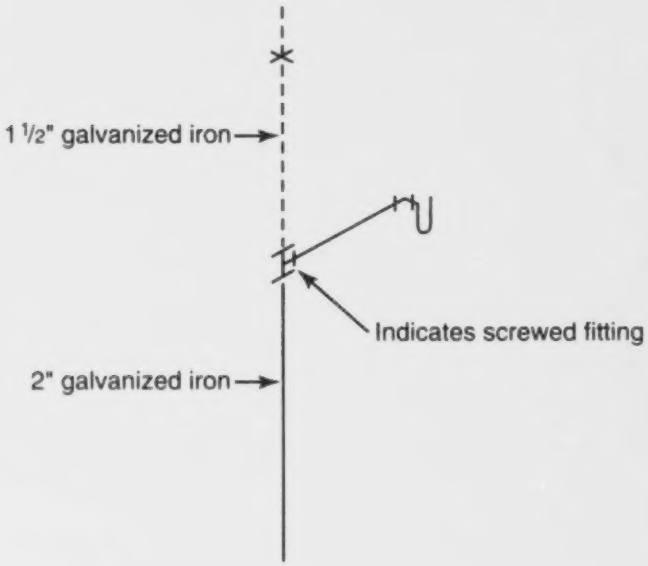


g. This is the same system without the house lines.



Information Sheet

h. Careful attention to detail can indicate type of fitting and direction of flow.



Sketches and Diagrams for Plumbers
Unit 2-C

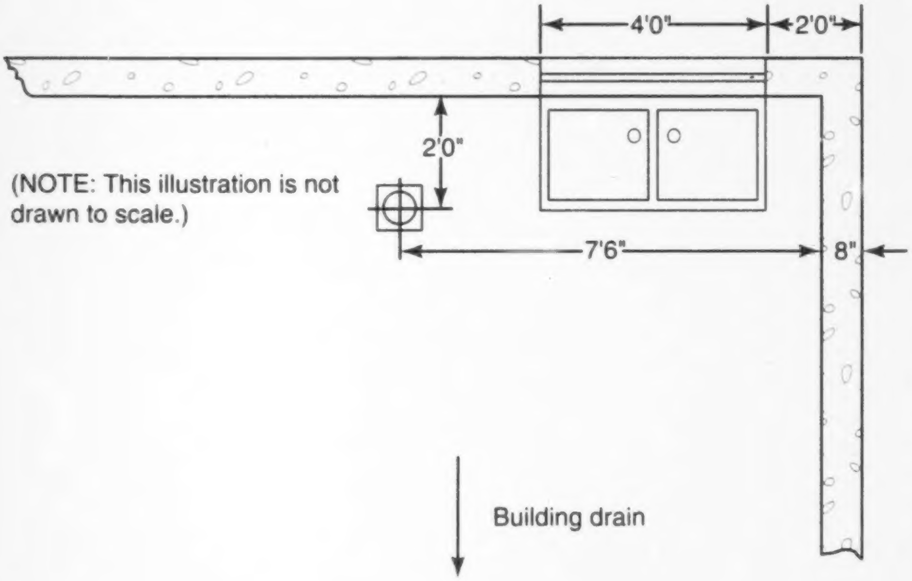
Assignment Sheet 1—Develop Three Types of Sketches of a Drainage System in a Basement Floor

Name ______________________________ Overall Rating ______________

Evaluation Criteria	Rating
• Directions are followed	______
• Drawing is correct	______
• Assignment is neat and completed on time	______

A. Plan view sketch

Directions: Develop a plan view sketch of the drainage system for the following illustration of a basement; show scale, building walls, window openings, and all piping.



(NOTE: This illustration is not drawn to scale.)

Assignment Sheet 1

B. Riser diagram

Directions: Using the illustration in Section A, develop a riser diagram of the drainage system.

C. Isometric sketch

Directions: Using the illustration in Section A, develop an isometric sketch of the drainage system.

Sketches and Diagrams for Plumbers
Unit 2-C

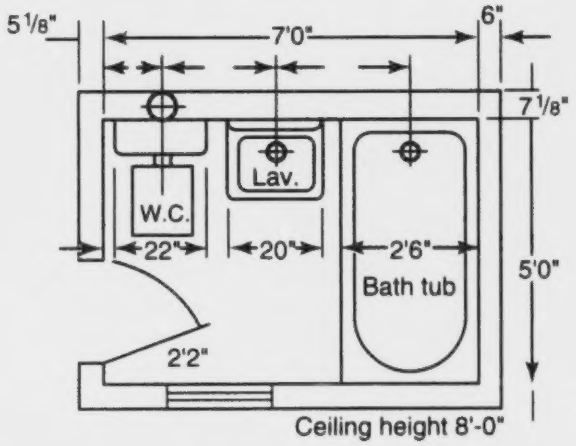
Assignment Sheet 2—Develop an Isometric Sketch of a Drainage System

Name ______________________________ Overall Rating ______________

Evaluation Criteria	**Rating**
• Directions are followed	______
• Isometric sketch is drawn correctly	______
• Piping is sized appropriately	______
• Assignment is neat and completed on time	______

Directions: Develop an isometric sketch showing the piping system for the following plan.

Note: Use a scale of $^1/_8$" = 1.



Note: Connect the waste for tub and lavatory to a separate sanitary tee just below the W.C.

A. Tools and materials

- Drawing board or large desk
- Triangle—45° (8" sides)
- Triangle—30° x 60° (10" long side)
- 2-H pencil
- Eraser
- Pencil sharpener
- Architect's scale
- Paper or appropriate material

Assignment Sheet 2

B. Procedure

☐ 1. Note the scale to be used.

☐ 2. Draw drainage layout on the plan.

☐ 3. Draw an isometric view to scale.

Note: Show inside or outside wall.

☐ 4. Draw isometric view of all drainage piping.

☐ 5. Size all piping according to local code or instructor's instructions.

Rough-In Locations
Unit 3-C

Objective Sheet

Unit Objective

After completing this unit, the student should be able to determine measurements from a manufacturer's specifications, determine rough-in locations for a bathroom, and establish grade lines for installing plumbing. The student should demonstrate these competencies by completing the assignment sheet and job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to rough-in locations with the correct definitions.
2. List three individuals who could be responsible for determining rough-in locations.
3. Select true statements concerning verbal orders.
4. Select true statements concerning sketches.
5. Complete statements concerning marking out locations.
6. Select information commonly found on manufacturer's specifications.
7. List information which can be determined from manufacturer's specifications.
8. List residential construction tradesworkers.
9. Discuss cooperating and coordinating techniques between plumbers and other tradesworkers.
10. Determine measurements from a manufacturer's specifications. (Assignment Sheet 1)
11. Determine rough-in locations for a bathroom. (Job Sheet 1)
12. Establish grade lines for installing plumbing. (Job Sheet 2)

Rough-In Locations
Unit 3-C

Information Sheet

1. **Terms and definitions**

    a. **Floor and ceiling joists**—Wood beams, usually 2″ x 8″, which are used to support the floor or ceiling

    Note: Refer to local code requirements.

    b. **Flooring**—Consists of a sub-floor (on base) and the finish floor

    Note: The finish floor can be made from various materials.

    c. **Journeyman plumber**—A plumber who is licensed to design, interpret, and install plumbing systems

    d. **Manufacturer's specifications**—Drawings and directions supplied by fixture manufacturers which indicate exact size, shape, and connections necessary to install the fixture

    e. **Plate**—The base of a studded wall; sometimes called the sole plate

    f. **Rough-in**—Preparing for and installing those pipes which will be covered by walls, ceilings, floors, and could be exposed in the basement

    g. **Sketches**—Drawings (usually hand drawn) showing all the piping arrangement and information needed to install the piping

    h. **Slab construction**—Concrete poured in a large flat surface which includes the entire house floor

    i. **Studs**—Wood beams, usually 2″ x 4″, which are used to support wall materials such as plasterboard, plaster, or paneling

    j. **Tradesworkers**—People engaged in various trades involved in the construction of buildings and other structures

2. **Individuals who could be responsible for determining rough-in locations**

    a. **Employer**

    b. **Customer**

    Note: The employer or customer gives rough-in locations by verbal orders, sketches, or by marking out locations

    c. **Journeyman plumber**

    Note: The journeyman plumber determines locations from scale measurements of blueprints or from manufacturer's specifications.

Information Sheet

3. Verbal orders

a. Verbal orders should be clearly understood by both parties.

b. Verbal orders should be acknowledged.

c. The plumber should keep clearly written notes about verbal orders, with dates and specific information.

d. Verbal orders from unfamiliar people should be verified by the employer or immediate superior.

e. Change orders must be verified and signed by the employer or immediate superior.

f. Persons giving verbal orders should be respected for their position.

Note: Employers and customers have the right to change their mind. They should receive courteous responses from workers.

4. Sketches

a. Sketches are prepared by the employer, foreman, customer, and/or worker.

b. Workers should discuss sketches with the person who made them.

Note: Do not wait until you get to the job site to wonder what some part of a sketch means.

c. Workers should keep sketches in a safe place until the job is approved.

Note: Losing a sketch may prevent you from defending the manner in which you did a job.

d. The worker in charge of an installation should be able to prepare or revise a sketch of the project.

e. A sketch should show all the information necessary to understand the job.

5. Marking out locations

a. Usually the journeyman plumber measures and marks out the locations using the rough-in book, but in some instances the employer or customer can do this.

Note: Customers should be notified immediately of any problems that their calculations will cause.

b. The plumber must have sufficient knowledge of construction methods.

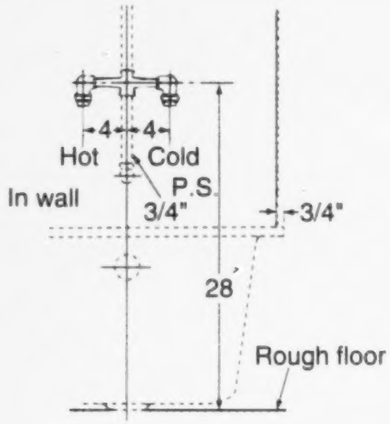
- Construction terminology
- Construction methods
- Construction materials

Information Sheet

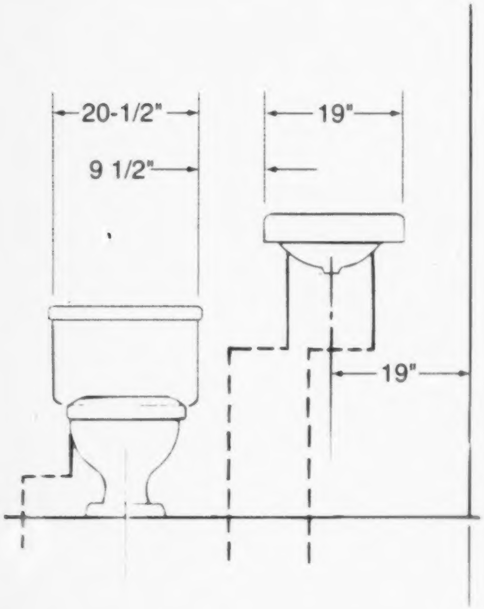
c. Considerations in marking locations for holes and openings should include:

- Plasterboard nails and other nailings
- Floor or ceiling joist locations
- Stud locations

Note: Lavatory, sink, and water closet distribution pipes can be offset (left or right) an inch or more, but shower valves must be centered perfectly.



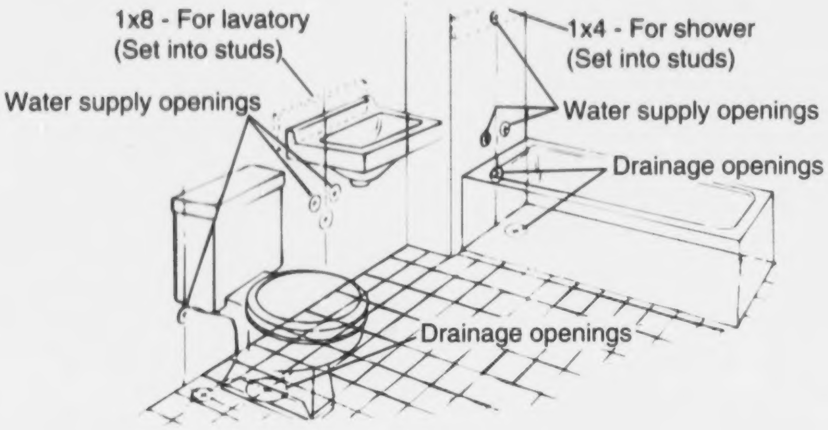
d. Holes for water pipes through the floor need not be in perfect position.



Note: The dotted lines indicate the positioning of pipes inside a wall in order to avoid going through or moving a beam.

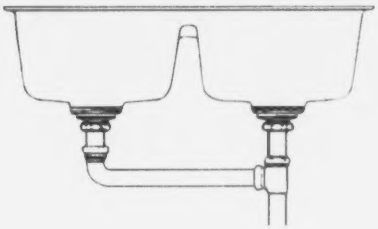
Information Sheet

e. Holes for water closet, shower, and bathtub drains must be in perfect position.



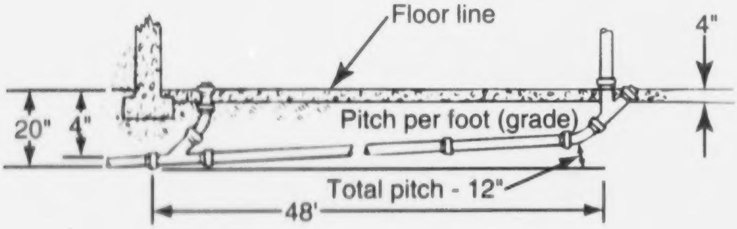
f. Holes for lavatory and sink drains can be offset an inch or two.

Note: Double-well kitchen sinks can be offset as much as the distance between well outlets.



g. Concrete slab or basement floor installations are usually done after the initial building foundation has been installed.

Note: In many cases, plumbers make provision for sewer and water access before the footing is poured.

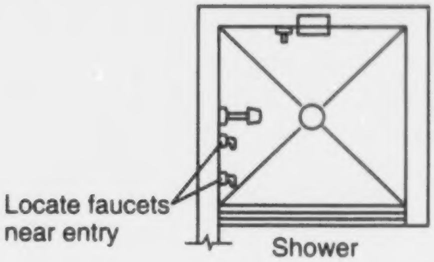


h. Piping installation in concrete slabs requires accurate measurements and pipe joints, as an error may necessitate breaking up the floor.

Information Sheet

6. Information commonly found on manufacturer's specifications

Note: A manufacturer's handbook or fixture installation sheet should be made available for the rough-in installation. Specifications vary between manufacturers, types, and models of fixtures. The plumber must know which model of fixture is to be installed before rough-in location can be determined. Some fixtures can be flexible in their rough-in locations, but others must be exact.



a. Centerline of drain outlet

b. Centerline of water supply

c. Height of fixture

d. Width of fixture

e. Depth of fixture

f. Height of water supply from rough floor

g. Height of drain outlet from rough floor

h. Rough-in location of rough floor (sub-floor)

i. Rough-in location of rough frame (stud wall)

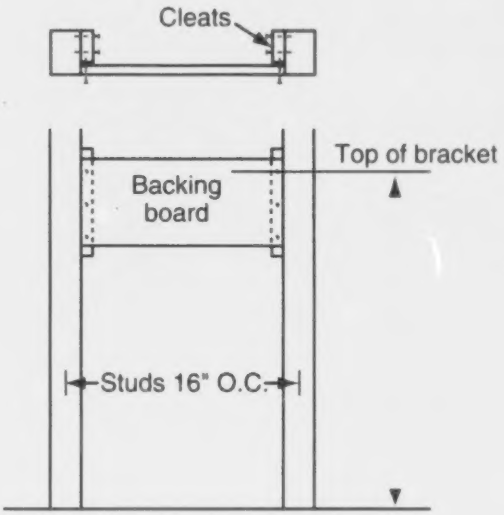
Note: The finish wall must be taken into consideration. If the finish wall is of unusual thickness, the thickness must be taken into consideration prior to determining pipe locations.

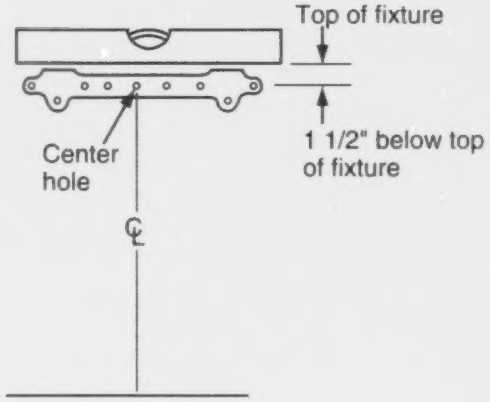
7. **Information which can be determined from manufacturer's specifications**

    a. Changes in wall structure

    Note: Manufacturer's specifications do not indicate piping arrangement. Plumbing codes are the first consideration for determining piping and fitting installation.

    b. Location of wall supports





8. **Tradesworkers in residential construction**

    a. Plumbers

    b. Masons or bricklayers

    c. Carpenters

    d. Electricians

    e. Drywall installers, tapers

    f. Roofers

    g. Telephone installers

    h. Heating and air conditioning installers

    i. Tile setters

    j. Painters

    k. Flooring installers

Information Sheet

9. Cooperating and coordinating techniques between plumbers and other tradesworkers

a. Respect the codes and regulations of other tradesworkers.

b. Give consideration to other tradesworkers' work.

c. A good employer or supervisor encourages each worker to own and carry his/her own tools and also discourages borrowing.

d. Use caution in lending tools to fellow workers.

Note: Learn the borrowing habits of your fellow worker before lending tools. Never lend tools to a stranger on the job, but be generous in lending tools to workers who are working in your immediate area because you may need their assistance also.

e. Do not use an extension cord that other tradesworkers are using; this can cause inconvenience.

f. Have a friendly attitude toward other tradesworkers; unfriendly attitudes can cause aggravation and additional work.

Note: Carpenters can easily cause additional work if not prompted to be cooperative and helpful.

Rough-In Locations
Unit 3-C

Assignment Sheet 1—Determine Measurements From a Manufacturer's Specifications

Name ______________________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Directions are followed	______
• Measurements for toilet are correct	______
• Measurements for sink are correct	______
• Measurements for tub are correct	______
• Assignment is neat and completed on time	______

Directions: Determine the measurements requested for the drawings on the following pages. Write your answers in the blanks provided.

Assignment Sheet 1

1. Determine the distances from:

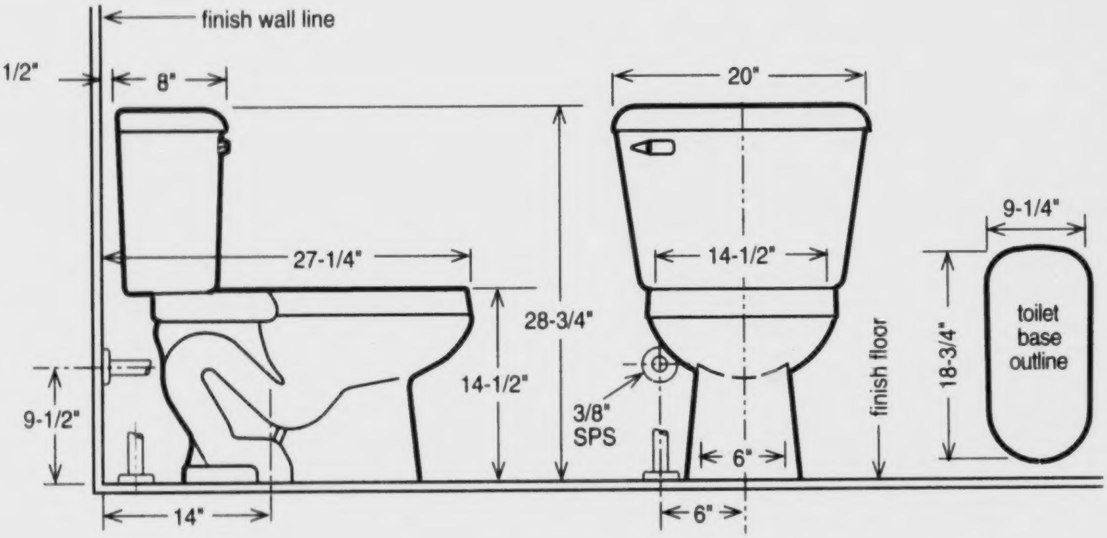
    a. Floor to bowl rim ______________

    b. Floor to tank cover top ______________

    c. Rough wall to center on drain outlet ______________

    d. Floor to cold water stub through wall ______________

    e. Back of water closet to front of water closet ______________



Information provided by Mansfield Plumbing Products, Inc....America's Best Value!

Assignment Sheet 1

2. Determine the following:

   a. Width of lavatory (front to back) ____________

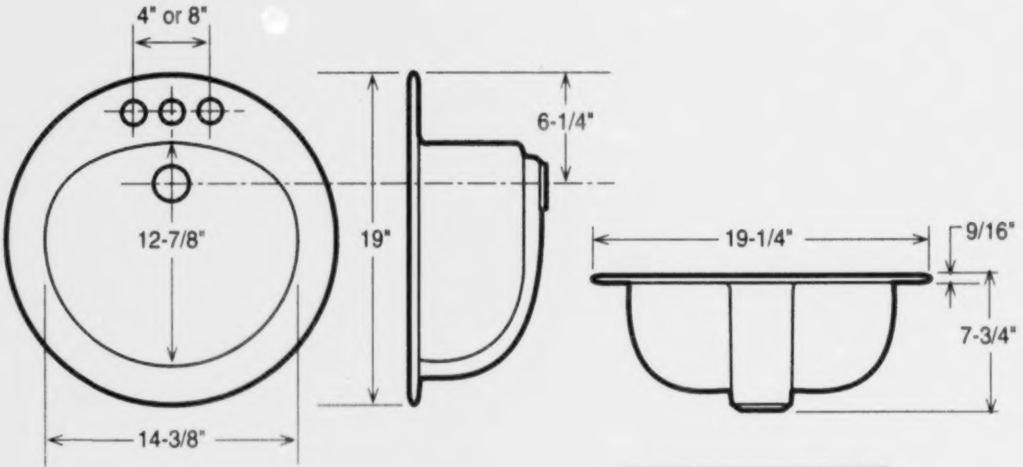
   b. Length of lavatory (side to side) ____________

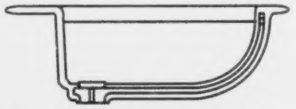
   c. Width of lavatory bowl (front to back) ____________

   d. Length of lavatory bowl (side to side) ____________

   e. Distance from center-line of hot water to center-line of cold water faucet ____________

   f. Distance from wall to drain center ____________




Standard safety feature on every Mansfield lavatory is concealed front overflow.

Information provided by Mansfield Plumbing Products, Inc....America's Best Value!

Assignment Sheet 1

3. Determine the following:

   a. Width of tub ______

   b. Length of tub ______

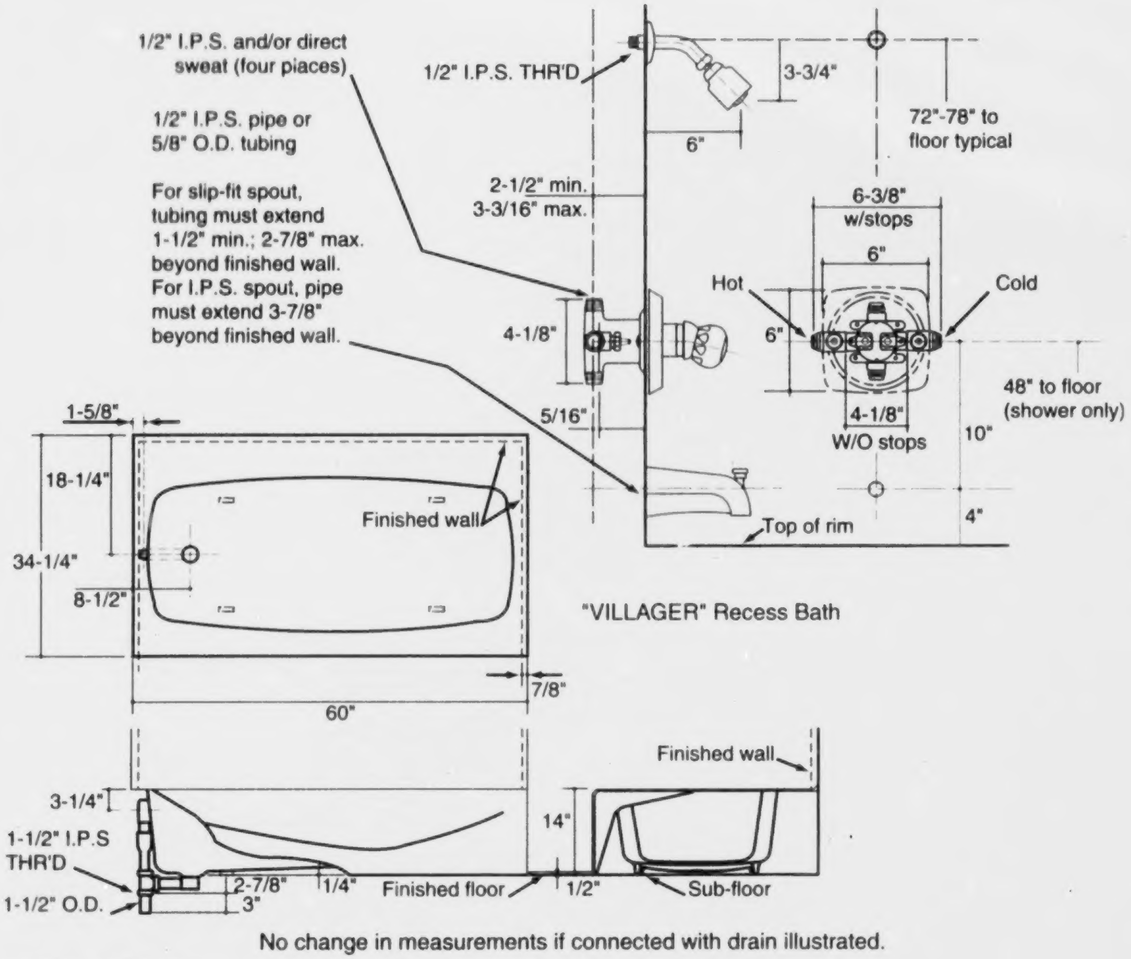
   c. Distance from the rear wall to center-line of tub drain ______

   d. Distance from the floor to rim of tub ______

   e. Distance from top of rim to center-line of tub spout ______

   f. Distance from the floor to center-line of shower head ______

   g. Distance from the floor to center of hot/cold water control (shower only) ______



"VILLAGER" Recess Bath

No change in measurements if connected with drain illustrated.

Courtesy of Kohler Co.

Rough-In Locations
Unit 3-C

Job Sheet 1—Determine Rough-In Locations for a Bathroom

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Used equipment properly	______
• Took accurate measurements	______
• Took correct information from specifications	______
• Marked correct rough-in locations	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Six-foot folding rule or steel tape
- Pencil—preferably a carpenter's pencil
- Manufacturer's specifications (rough-in book) for a tub, lavatory, and water closet

B. Procedure

Note: Make drawing full size on concrete floor.

☐ 1. Determine approximate fixture locations.

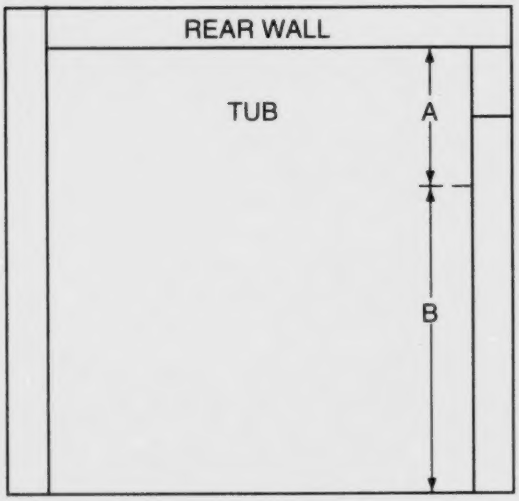
☐ 2. Study the specifications.

☐ 3. Measure the room (inside dimensions).

☐ 4. Mark the width of the tub on the floor (=Dimension A). (Figure 1)

Job Sheet 1

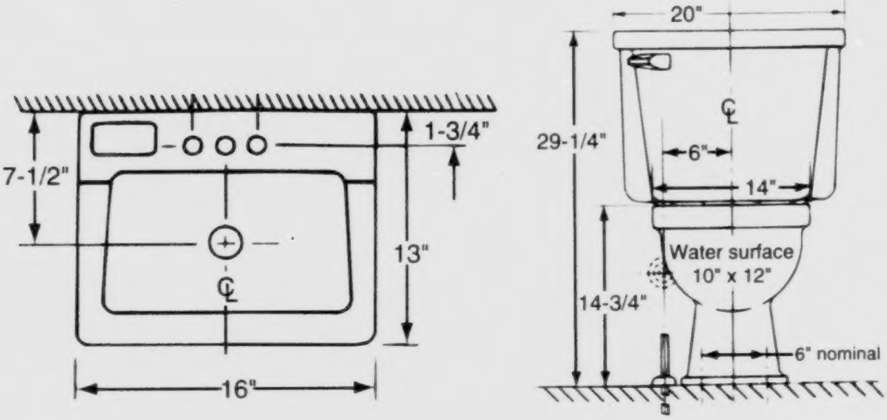
FIGURE 1



☐ 5. Determine the remaining distance to the far wall (=Dimension B). (Figure 1)

☐ 6. Add the lavatory width and water closet width to the nearest inch (=Dimension C). (Figure 2)

FIGURE 2



☐ 7. Subtract dimension C from dimension B to determine leftover space (=Dimension D).

☐ 8. Divide leftover space into three equal spaces (=Dimension E).

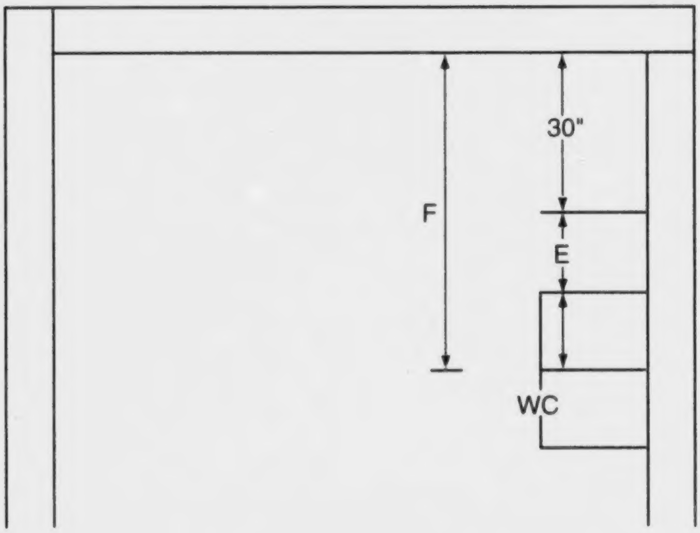
Note: $E = \frac{1}{3} D$

Job Sheet 1

☐ 9. From the rear wall, measure A (the width of the tub) plus E, plus 1/2 the width of the water closet (=Dimension F). (Figure 3)

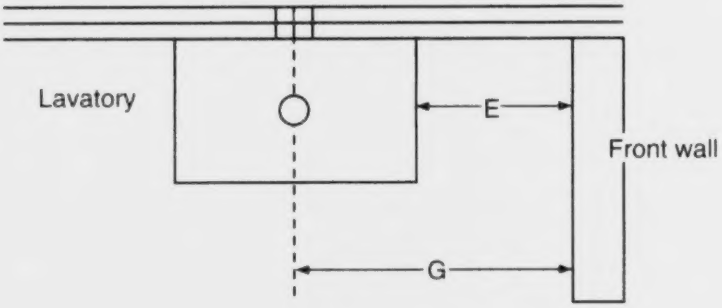
Note: Check the specifications. This mark should be 12" off the side wall.

FIGURE 3



☐ 10. From the front wall, measure E, plus 1/2 the width of the lavatory (=Dimension G). (Figure 4)

FIGURE 4



☐ 11. Mark F and G on the wall plate, making a line from one edge to the other.

☐ 12. Measure from each side of the lavatory drain mark and draw lines for the water risers.

Note: Check specifications for measurements.

Job Sheet 1

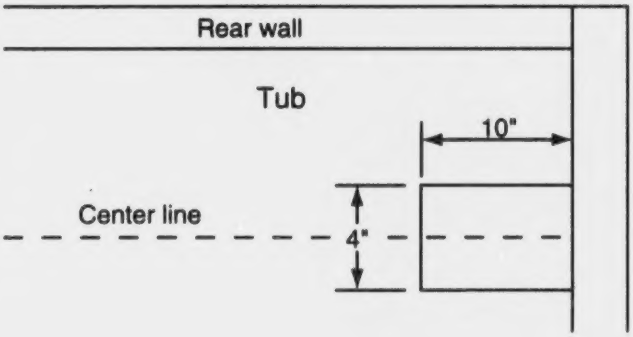
☐ 13. Mark the water closet riser.

Note: Check specifications for measurement.

☐ 14. Determine center-line of tub drain and mark plate.

☐ 15. Mark tub drain cut-out on floor—4″ wide, 10″ long, on center-line of drain. (Figure 5)

FIGURE 5



☐ 16. Measure from each side of the tub drain mark on the plate and mark out for the water line.

Note: If carpenters have not provided proper stud spacing, a stud may have to be moved.

Job Sheet 1

☐ 17. Center all markings on plate and draw a line.

Note: The finished project should coincide with Figure 6 on the following page.

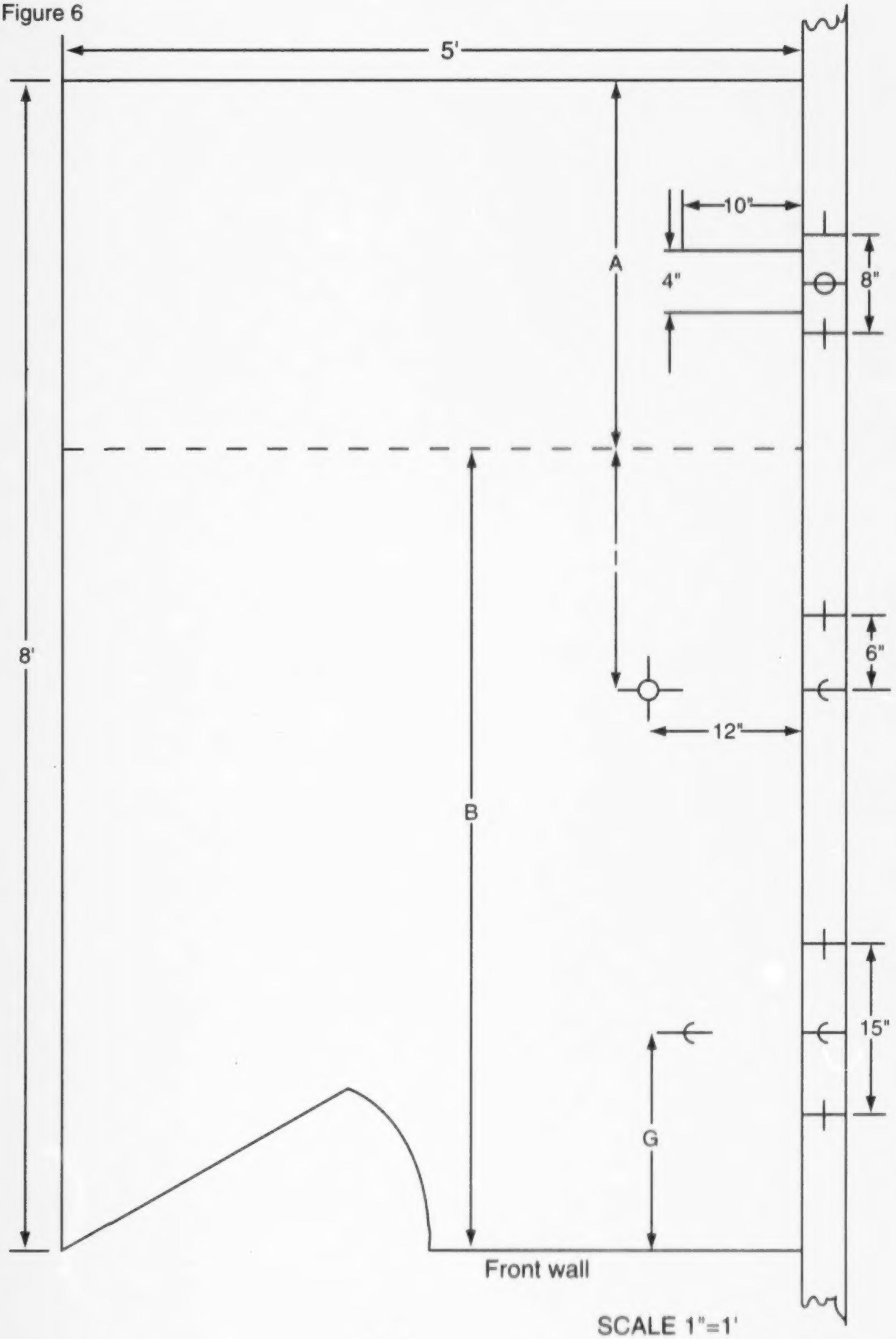
Evaluator's Comments: ______________________________

____

____

Job Sheet 1

Figure 6



Rough-In Locations
Unit 3-C

Job Sheet 2—Establish Grade Lines for Installing Plumbing

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Used equipment properly	______
• Read blueprint correctly	______
• Located plumbing walls accurately	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

Using form work for a concrete slab and construction plans, establish grade lines and partition walls for installing building drain and water supply lines. Grade lines must be in accordance with local codes and partitions must be correctly located.

A. Equipment and materials

- 100′ tape
- Blueprint
- Nylon string
- Wooden stakes

B. Procedure

☐ 1. Check form work length and width for square, using a 100′ tape.

☐ 2. Locate plumbing walls, using a blueprint.

☐ 3. Stretch nylon string at points where plumbing will be installed.

☐ 4. Review established grade lines with contractor.

Evaluator's Comments: ____

____

____

Building and Plumbing Codes
Unit 4-C

Objective Sheet

Unit Objective

After completing this unit, the student should be able to use the BOCA Basic/National Plumbing Code and apply code regulations to a plumbing installation. The student should demonstrate these competencies by completing the assignment sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to building and plumbing codes with the correct definitions.
2. Discuss the membership of a plumbing code governing board, its authority, and its duties.
3. Describe the benefits of zoning laws, building codes, and plumbing codes.
4. Select major categories that should be included in a plumbing code.
5. List basic principles of plumbing codes.
6. Select true statements concerning illegal fittings and installations.
7. Apply code regulations to a plumbing installation. (Assignment Sheet 1)
8. Use the BOCA Basic/National Plumbing Code. (Assignment Sheet 2)

Building and Plumbing Codes
Unit 4-C

Information Sheet

1. **Terms and definitions**

   a. **Board of Health**—Local board that generally regulates and enforces the plumbing code

   Note: In some states the building department performs these tasks.

   b. **BOCA Basic/National Plumbing Code**—Plumbing code resulting in 1982 from an agreement between the Building Officials and Code Administration (BOCA) and the American Insurance Association (AIA) which is generally accepted as a basis for developing state and local plumbing codes through much of the country

   Note: This code is meant to be only a guideline for state and local codes; the 12th edition of the code was published in 1993.

   c. **Building code**—Set of rules governing the quality of construction in a community

   d. **Inspection**—Checking to see if the work conforms to the code specifications

   e. **License**—Document stating that the holder has passed trade tests and has proved the ability to perform satisfactory work

   f. **Plumbing code**—Set of rules governing the quality of plumbing installations

   Note: A plumbing code can be established at either the state or local level.

   g. **Plumbing inspector**—Person authorized to inspect and approve or disapprove plumbing installations according to code specifications

   h. **Zoning laws**—Rules which specify type of construction permitted in certain areas of a city or town

2. **Plumbing code governing board**

   a. Membership

   - Member of the city board of health
   - Chief plumbing inspector
   - One or more master plumbers
   - One or more journeyman plumbers

   Note: Boards may vary in the number of their members, the professional background of their members, and their authority in administering the code.

Information Sheet

b. Administrative authority

- State board
- Local board

Note: States vary in the administration of their individual codes. Some states have one state code; other states permit each locality to administer the code.

c. Duties of the board might include:

- Develop regulations which apply to local conditions for plumbing installations
- Develop amendments to the code on a regular basis
- Present the code and/or amendments to the city or town council for adoption into law
- Support the plumbing inspectors in their efforts to enforce the code
- Issue licenses and permits
- Take necessary steps to enforce the code

Note: These could include a refusal to connect to city sewer or water, and/or prosecution in the courts.

3. Benefits of zoning laws, building codes, and plumbing codes

a. Zoning laws

- Regulate size and type of business or industry in specific geographical locations
- Separate residential areas from industrial areas
- Create business areas which make shopping more convenient
- Determine minimum building lot sizes and distance between buildings

b. Building codes

- Determine the quality of construction in a community
- Protect public health, safety, and quality of life in a community

Note: Building codes vary as to industrial, business, and residential construction. They are administered by a chief building inspector whose staff studies plans, issues permits, inspects construction, approves or disapproves construction, and maintains records of current and past constructions.

c. Plumbing codes

- Protect the health of the community
- Regulate all construction whether industrial, business, or residential

Information Sheet

- Permit grievances or complaints by the plumbing contractor to be reviewed by the board of health or the court

  Note: Plumbing codes are usually administered by the community board of health and are enforceable by court action.

4. Major categories of a plumbing code

a. Basic principles upon which the local code is determined

b. Terms and definitions

c. Basic regulations

Examples: Quality of materials and workmanship, pitch of piping, distances between clean-outs

d. Types of materials and siding

e. Types and quality of joints

f. Types and location of traps and clean-outs

g. Types and quality of fixtures

h. Design of water pipe, drainage, and vents

i. Provisions for inspections and testing

5. Basic principles of plumbing codes

Note: These principles are based on the BOCA Basic/National Plumbing Code, 12th edition, 1993.

a. All premises intended for human habitation, occupancy, or use shall be provided with a supply of pure and wholesome water, neither connected with unsafe water supplies nor subject to the hazards of backflow.

b. Plumbing fixtures and devices shall be supplied with water in sufficient volume and at pressures adequate to enable them to function satisfactorily and without undue noise under all normal conditions of use.

c. Hot water shall be provided to fixtures which normally require hot water for their proper use.

d. Plumbing shall be designed and adjusted to use the minimum quantity of water consistent with proper performance and cleaning.

e. Devices for heating and storing water shall be designed and installed to guard against dangers from explosion or overheating.

Information Sheet

f. Every building having plumbing fixtures installed and intended for human habitation, occupancy, or use on premises abutting on a street, alley, or easement in which there is a public water supply and sewer service shall have a connection with the water supply and sewer.

g. Each family dwelling unit shall have at least one water closet, one lavatory, one kitchen type sink, and one bathtub or shower to meet the basic requirements of sanitation and personal hygiene. All other structures for human occupancy or use shall be equipped with no less than one water closet and one lavatory.

h. Plumbing fixtures shall be made of durable, smooth, nonabsorbent, and corrosion-resistant material, and shall be free from concealed fouling surfaces.

i. The drainage system shall be designed, constructed, and maintained to guard against fouling, deposit of solids, and clogging, and with adequate cleanouts so arranged that the pipes may be readily cleaned.

j. The piping of the plumbing system shall be of durable material, free from defective workmanship, and so designed and constructed as to give satisfactory service for its reasonable expected life.

k. Each fixture directly connected to the drainage system shall be equipped with a liquid seal trap.

l. The drainage system shall be designed to provide an adequate circulation of air in all pipes with no danger of siphonage, aspiration, or forcing of trap seals under conditions of ordinary use.

m. Each vent terminal shall extend to the outer air and be installed to minimize the possibilities of clogging and the return of foul air to the building.

n. The plumbing system shall be subjected to such tests as will effectively disclose all leaks and defects in the work or the material.

o. No substance which will clog the pipes, produce explosive mixtures, destroy the pipes or their joints, or interfere unduly with the sewage-disposal process shall be allowed to enter the building drainage system.

p. Proper protection shall be provided to prevent contamination of food, water, sterile goods, and similar materials by backflow of sewage. When necessary, the fixture, device, or appliance shall be connected indirectly with the building drainage system.

q. No water closet, urinal, lavatory, bathtub, or shower shall be located in a room or compartment which is not properly lighted, heated, and ventilated.

r. If water closets or other plumbing fixtures are installed in buildings where there is no sewer, provision shall be made for disposing of the building sewage by an approved method of sewage treatment and disposal.

s. Where a plumbing drainage system may be subjected to backflow of sewage from the public sewer, provision shall be made to prevent its overflow in the building.

t. Plumbing systems shall be maintained in a safe and serviceable condition.

Information Sheet

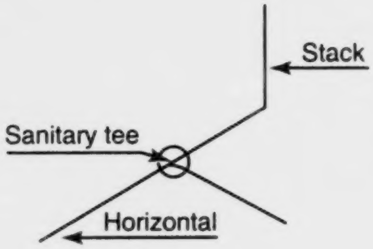
u. All plumbing fixtures shall be so installed with regard to spacing as to be accessible for their intended use and cleaning.

v. Plumbing shall be installed with due regard to preservation of the strength of structural members, and prevention of damage to walls and other surfaces through fixture usage.

w. Sewage or other waste shall not be discharged into surface or subsurface water unless it has first been subjected to an approved form of treatment.

6. Illegal fittings and installations

a. A sanitary tee fitting should not be used to change the direction of flow of horizontal drainage piping.



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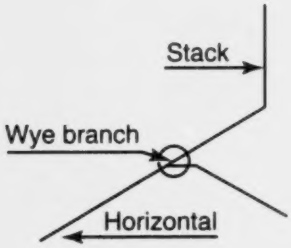
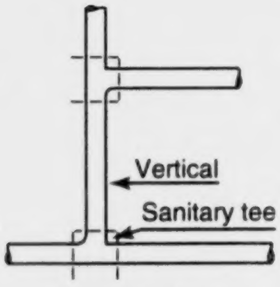


Correct

b. A sanitary tee fitting should not be used to change direction from vertical to horizontal flow of drainage pipe.



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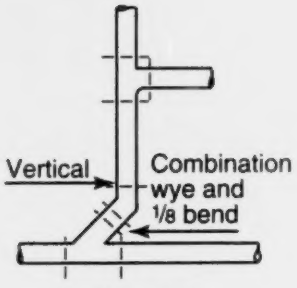
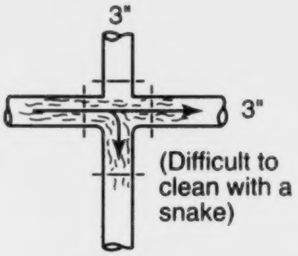


Correct

c. A double sanitary tee should not be used if the outlet is the same size as the inlet.



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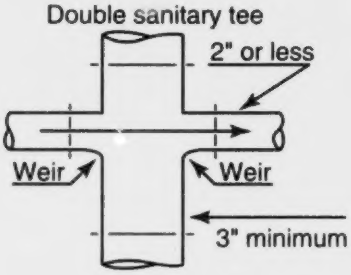
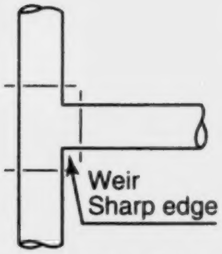


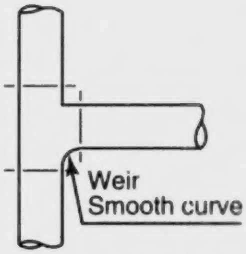
Correct

d. A single or double tee should not be used in either vertical or horizontal drainage piping.



Straight tee fitting

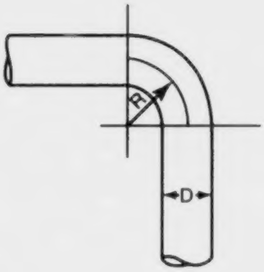
Incorrect



Sanitary tee fitting

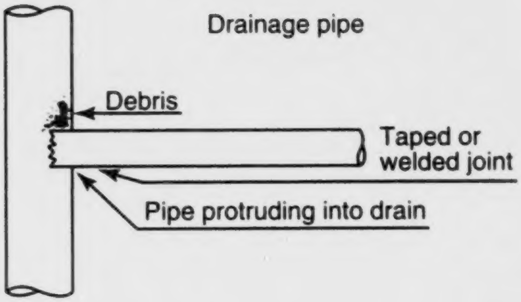
Correct

e. A 90° bend should have a radius not less than the diameter of the pipe.

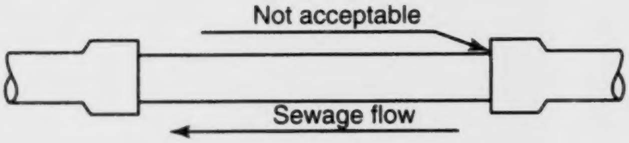


Information Sheet

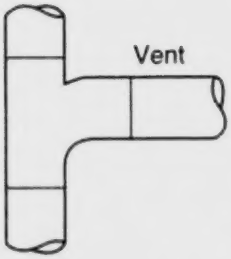
f. Connections into the drainage system should be made with approved fittings and not by drilling or tapping.



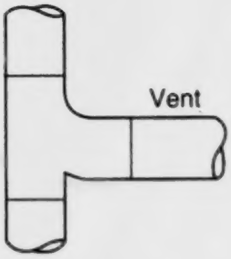
g. Double hub caulked fittings and pipes (cast iron) shall not be used except for vent lines.



h. A sanitary tee fitting in a vertical vent line should be inverted.



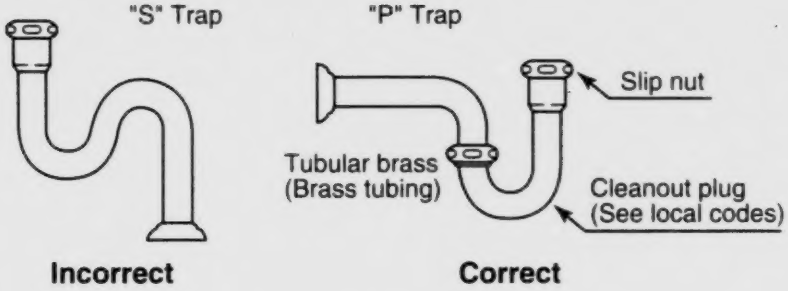
Incorrect



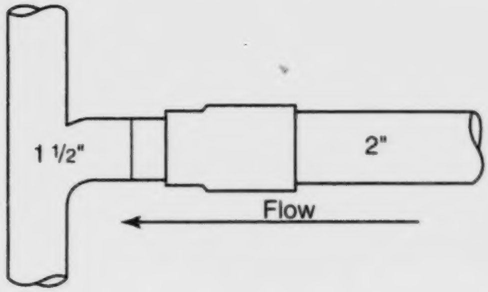
Correct

Information Sheet

i. Traps should have an accessible cleanout or be able to be disassembled.



j. Fittings which reduce the flow in a drainage system are not permitted.



Building and Plumbing Codes
Unit 4-C

Assignment Sheet 1—Apply Code Regulations to a Plumbing Installation

Name ______________________ Overall Rating ______________

Evaluation Criteria	**Rating**
• Directions are followed	________
• All answers are correct	________
• Assignment was neat and completed on time	________

Directions: Using either a state or local plumbing code book, list the type and size of fitting identified by letter on the following drawing.

A. ______________________

B. ______________________

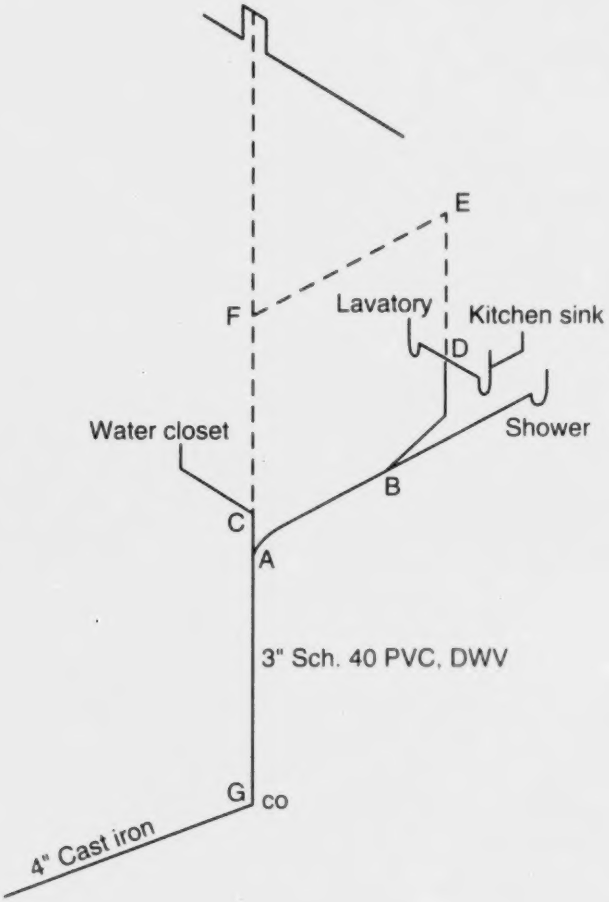
C. ______________________

D. ______________________

E. ______________________

F. ______________________

G. ______________________



Building and Plumbing Codes
Unit 4-C

Assignment Sheet 2—Use the BOCA Basic/National Plumbing Code

Name ______________________________ Overall Rating ______________

Evaluation Criteria	**Rating**
• Directions are followed	______
• All answers are correct	______
• Assignment was neat and completed on time	______

Directions: Answer the following questions using the latest edition of the BOCA Basic/National Plumbing Code. Write the letters corresponding to the correct answers in the blanks provided.

1. A 1 1/2″ drain with a 1/2″ trap can be ______________ from trap weir to vent fitting.

   a 3′–6″

   b. 5′

   c. 8′

   d. 10′

2. The minimum size water supply line for a bathtub is ______________.

   a. 1/2″

   b. 3/8″

   c. 3/4″

   d. None of the above

3. The minimum size water supply line for a flush tank water closet is ____________.

   a. 1/2″

   b. 3/8″

   c. 3/4″

   d. 1″

Assignment Sheet 2

4. The vent from an individual fixture is known as a _______________.

    a. Crown vent

    b. Loop vent

    c. Stack vent

    d. Individual vent

5. Every building in which plumbing is installed shall have at least one main stack, not less than ________________ in diameter.

    a. 2″

    b. 1 1/2″

    c. 3″

    d. 4″

6. A vent connecting one or more individual vents with a vent stack or stack vent is a ________________.

    a. Branch vent

    b. Loop vent

    c. Crown vent

    d. Stack vent

7. A branch vent that serves two or more traps and extends from the downstream side of the highest fixture connection of a horizontal branch to the vent stack is a ________________.

    a. Loop vent

    b. Branch vent

    c. Circuit vent

    d. None of the above

8. A vertical vent that is a continuation of the drain to which it connects is called a ________________.

    a. Cleanout

    b. Common vent

    c. Cross connection

    d. Continuous vent

Assignment Sheet 2

9. A pipe which carries waste water or water borne wastes in a building drainage system is called ________________.

   a. Drain
   b. Continuous waste
   c. Flooded
   d. None of the above

10. That part of the drainage system which extends from the end of the building drain and conveys its discharge to a public sewer is called a ________________.

   a. Building drain
   b. Building trap
   c. Building sewer
   d. Building drainage

Metric Measurement for Plumbers
Unit 5-C

Objective Sheet

Unit Objective

After completing this unit, the student should be able to convert English measurements into metric measurements and calculate volumes of tanks. The student should demonstrate these competencies by completing the assignment sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to metric measurement with the correct definitions.
2. Write common metric abbreviations.
3. Convert approximate pipe sizes and lengths from the English system to the metric system.
4. Convert temperature measurements from the English system to the metric system.
5. Convert liquid measurements from the English system to the metric system.
6. Convert weight (mass) measurements from the English system to the metric system.
7. Calculate the volume of rectangular and cylindrical tanks.
8. Convert cubic feet and inches to gallons.
9. Read U.S. customary and metric rules. (Assignment Sheet 1)
10. Convert English system measurements to metric measurements. (Assignment Sheet 2)

Metric Measurement for Plumbers
Unit 5-C

Information Sheet

1. **Terms and definitions**

    a. **10th multiple**—Referring to the metric system as being divisible into ten parts

    Note: The English system has variable measurements lists; lineal lists 12 inches to the foot; weight lists 16 ounces to the pound; liquid lists 32 ounces to the quart.

    b. **Area**—A measurement of the surface included within a two-dimensional set of lines

    Note: Area is measured in square units.

    c. **English system**—System currently used in the United States; measurements are in inches, feet, and yards (lengths); pounds and ounces (weights); and temperature is measured in Fahrenheit degrees.

    d. **Linear**—Referring to lines or the measurement of lines (lengths and widths)

    e. **Mass**—Word adopted by the metric system for weight

    f. **Maximum density of water**—The volume water reaches at 39.2°F

    Note: At 39.2°F water has become cool and has contracted to its smallest volume. At lower or higher temperatures it will start to expand.

    g. **Metric system**—System used in most of the world; measurements are in meters (lengths); grams (weights); liters (volume); and temperature is measured in Celsius degrees.

    h. **SI**—International System of Units; modern version of the metric system

    i. **Volume**—The amount of space occupied by a three-dimensional object

    Note: Volume is measured in cubic units.

2. **Common metric abbreviations**

    a. **m**—meter

    b. **cm**—centimeter

    c. **mm**—millimeter

    d. **C°**—Celsius degree

    e. **F°**—Fahrenheit degree

    f. **l**—liter

    g. **ml**—milliliter

Information Sheet

h. **g**—gram

i. **kg**—kilogram

3. **How to convert pipe sizes and lengths from the English system to the metric system**

Note: Since pipe diameters are available in standard sizes, the actual measurement is matched to the closest pipe size.

a. 1″ = 25.40 mm; to convert inches to millimeters multiply by 25.4.

Example: 4″ = 4 x 25.4 = 101.6 mm = 100 mm pipe

Note: The millimeter is used to measure very small distances such as nut sizes and certain pipe diameters.

b. 1″ = 2.54 cm; to convert inches to centimeters multiply by 2.54.

Example: 18″ = 18 x 2.54 = 45.72 cm

Note: The centimeter is used to measure short distances.

c. 1′ = 0.3048 m; to convert feet to meters multiply by 0.3048.

Example: 4′ = 4 x 0.3048 = 1.2 m

Note: The meter is used to measure long distances.

d. Applications—Nominal pipe size

- 1″ diameter pipe = 25 mm pipe
- 1 1/4″ diameter pipe = 32 mm pipe
- 1 1/2″ diameter pipe = 38 mm pipe
- 2″ diameter pipe = 50 mm pipe
- 3″ diameter pipe = 75 mm pipe
- 4″ diameter pipe = 100 mm pipe

Information Sheet

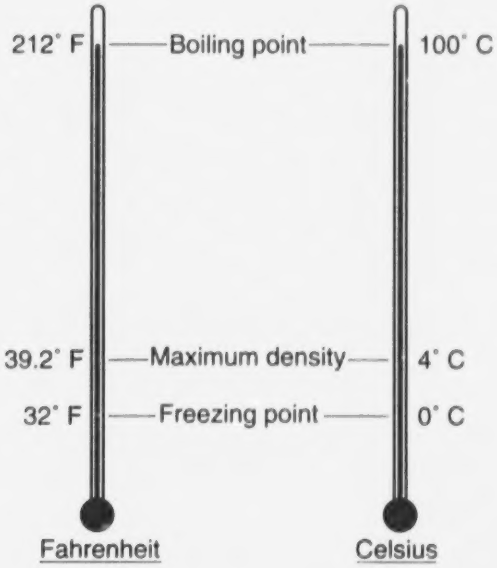
4. How to convert temperature measurements from the English system to the metric system

a. Conversions—To find C° when you know F°, divide by 1.8 after subtracting 32.

Example: 212°F − 32 = 180 ÷ 1.8 = 100°C

b. Applications

- 0°C = 32°F = freezing point
- 4°C = 39.2°F = maximum density of water
- 37°C = 98.6°F = normal human temperature
- 100°C = 212°F = boiling point of water



5. How to convert liquid measurements from the English system to the metric system

a. 1 gallon = 3.785 liters; to convert gallons to liters multiply by 3.785.

Example: 5 gallons = 5 x 3.785 = 18.925 liters = 18.9 liters (rounded)

b. 1 quart = 0.946 liters; to convert quarts to liters multiply by 0.946.

Example: 4 quarts = 4 x 0.946 = 3.784 liters

c. Applications

- 30-gallon water heater = 114 liters
- 40-gallon water heater = 151 liters
- 60-gallon water heater = 227 liters

6. How to convert weight (mass) measurements from the English system to the metric system

a. 1 pound = .4539237 kilograms; to convert pounds to kilograms multiply by .4539

Example: 20 pounds = 20 x .4539 = 9.0780 = 9 kg (rounded)

b. Applications

- 22 lb. wall hung lavatory = 10 kg
- 88 lb. water closet = 40 kg
- 154 lb. cast iron bathtub = 70 kg

7. How to calculate area and volume of tanks

a. Rectangular tanks

- Area of a rectangle = length x width

  Example: Area of a rectangle 7′ long and 3′ wide = 7 x 3 = 21 square feet

- Volume of a rectangular tank = length x width x height

  Example: Volume of rectangular tank 10′ long, 4′ wide, and 6′ high = 10 x 4 x 6 = 240 cubic feet

b. Cylindrical tanks

- Area of a circle = Π x the square of the radius (Πr^2) or .7854 d^2

  Note: Π = 3.14; r = ½ diameter

  Example: Area of circle with a 3′ radius

$A = \Pi r^2$	OR	$A = .7854 (d^2)$
$A = 3.14 \times 3^2$		$A = .7854 (6^2)$
$A = 3.14 \times 9$		$A = .7854 (36)$
A = 28.26 square feet		A = 28.27 square feet

Information Sheet

- Volume of a cylindrical tank = area (Πr^2) x height

  Example: Volume of a cylindrical tank with a 3′ radius and 6′ high

  $V = \Pi r^2 \times \text{height}$

  $V = 3.14 (3^2) \times 6$

  $V = 3.14 \times 9 \times 6$

  V = 169.56 cubic feet

8. **How to convert cubic feet and inches to gallons**

   a. 1 cubic foot = 7.48 gallons; to convert cubic feet to gallons multiply by 7.48.

   Example: 6 cubic feet = 6 x 7.48 = 44.88 gallons

   b. 231 cubic inches = 1 gallon; to convert cubic inches to gallons divide by 231.

   Example: 400 cubic inches = $^{400}/_{231}$ = 1.73 gallons

Metric Measurement for Plumbers
Unit 5-C

Student Supplement 1—Standard and Metric Measurement Units

Values of prefixes associated with metric measurement (Table 1)

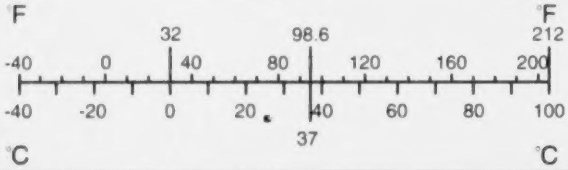
The basic units of measurement in the metric system are the meter (length), liter (capacity), and gram (mass or weight). Other units are named by adding the following prefixes to meter, liter, or gram. Since all measurement units in the metric system are powers of 10, metric prefixes make measurements easily understood. A millimeter, for instance, is one thousandth of a meter.

Table 1: Prefixes associated with metric measurement

Prefix	Value
kilo (k)	one thousand (1000)
hecto (h)	one hundred (100)
deka (da)	ten (10)
deci (d)	one tenth ($^1/_{10}$)
centi (c)	one hundredth($^1/_{100}$)
milli (m)	one thousandth ($^1/_{1000}$)

Student Supplement 1

U.S. Customary Unit/Equivalents		**Metric**
	Length	
Inch	.083 foot	25.40 millimeters 2.54 centimeters
	3.987 inches	Decimeter
Foot	1/3 yard or 12 inches	0.305 meter
Yard	3 feet or 36 inches	0.914 meter
	39.370 inches	Meter
	Capacity	
Fluid ounce	1.804 cubic inches	29.573 milliliters
Pint	16 fluid ounces or 28.875 cubic inches	0.473 liter
Quart	2 pints or 57.75 cubic inches	0.946 liter
Gallon	4 quarts or 231 cubic inches	3.785 liters
	Weight (Mass)	
.035 ounce		Gram
Ounce		28.349 grams
Pound	16 ounces	.453 kilograms
2.2046 pounds		Kilogram
	Temperature	
Fahrenheit		Celsius
32°F (Freezing point)		0°C
98.6°F (Normal body temperature)		37°C
212°F (Boiling point)		100°C
Degree Fahrenheit	(°F−32) ÷ 1.8	Degree Celsius (C)



Metric Measurement for Plumbers
Unit 5-C

Assignment Sheet 1—Read U.S. Customary and Metric Rules

Name ______________________________ Overall Rating ____________

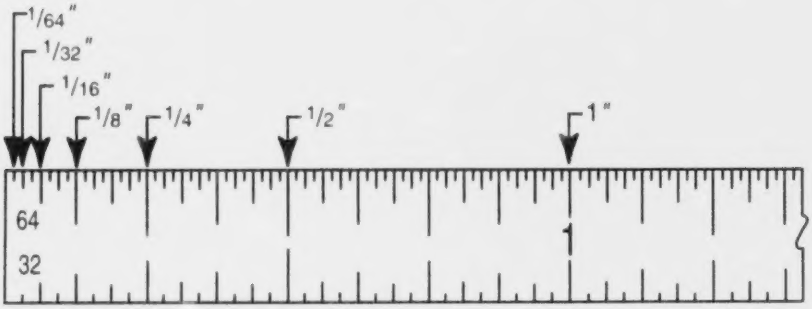
Evaluation Criteria	Rating
• Directions have been followed	______
• Minimum of 85% of the questions have been answered correctly	______

Introduction: American industry is changing from the U.S. customary system to the metric system. For this reason, you will find U.S. customary/metric steel rules with an inch scale on one edge (graduated in sixteenths, thirty-seconds, or sixty-fourths) and a centimeter scale on the other side (graduated in millimeters). You must work with decimals and fractions to make accurate measurements with metric and inch rules.

Reading fractional measurements on a U.S. customary rule

Note: All rules are read similarly. However, some rules are graduated with more divisions than others. The enlarged rule illustrated in Figure 1 is graduated in sixty-fourths of an inch on the top scale and thirty-seconds of an inch on the bottom scale. The staggered graduations are for halves, quarters, eighths, sixteenths, thirty-seconds, etc.

Figure 1

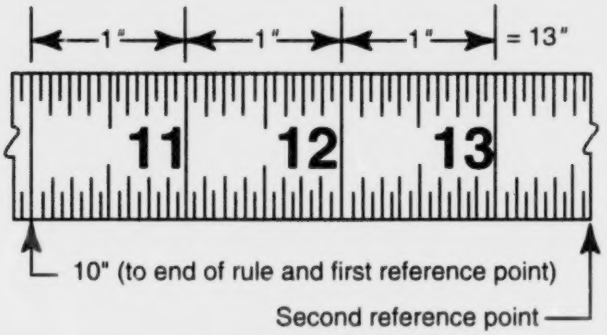


1. Align the end of the rule with one reference point.

Assignment Sheet 1

2. Determine the number of whole units between the end of the rule and the second reference point (see Figure 2).

Figure 2



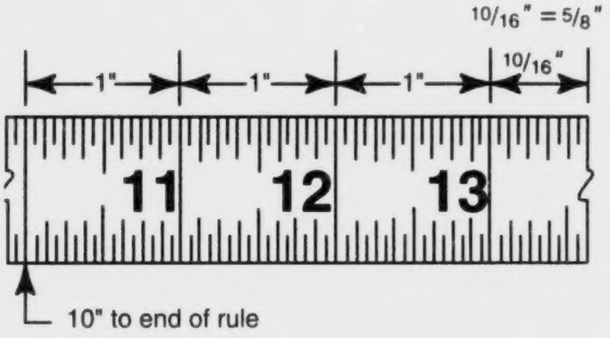
10" (to end of rule and first reference point)

Second reference point

3. Determine the number of fractional units between the last whole unit and the second reference point by counting the divisions.

4. Place this number over the rule scale (the rule in Figure 3 below is scaled in sixteenths of an inch) and reduce this fraction if possible.

Figure 3



10" to end of rule

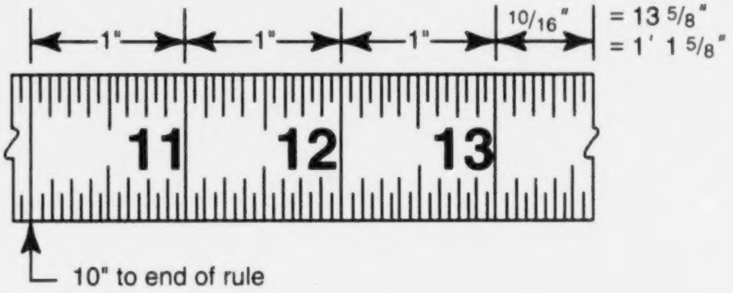
Assignment Sheet 1

5. Make a mixed fraction by adding this reduced fraction to the number of whole units counted earlier; convert inches to feet if necessary by dividing 12 into the total whole inches measured (see Figure 4).

Example: 3 inches + $^{5}/_{8}$ inch = 3 $^{5}/_{8}$ inches

Figure 4

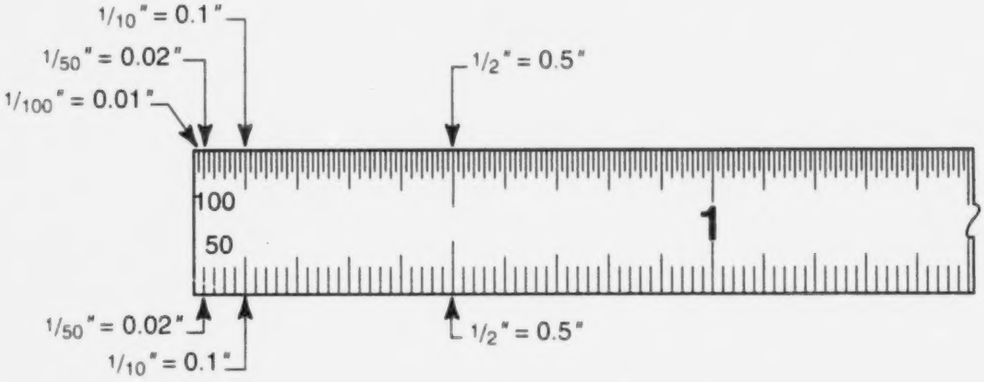
3 inches + $^{5}/_{8}$ inch = 3 $^{5}/_{8}$ inches



Reading decimal-inch measurements on a U.S. customary rule

Note: U.S. customary rules with decimal-inch increments allow for more precise measurements. The top scale on the enlarged rule illustrated in Figure 5 below is graduated in one-hundredths of an inch (0.01 inch). The bottom scale is graduated in fiftieths of an inch (0.02 inch). The staggered graduations are for halves, tenths, and fiftieths.

Figure 5



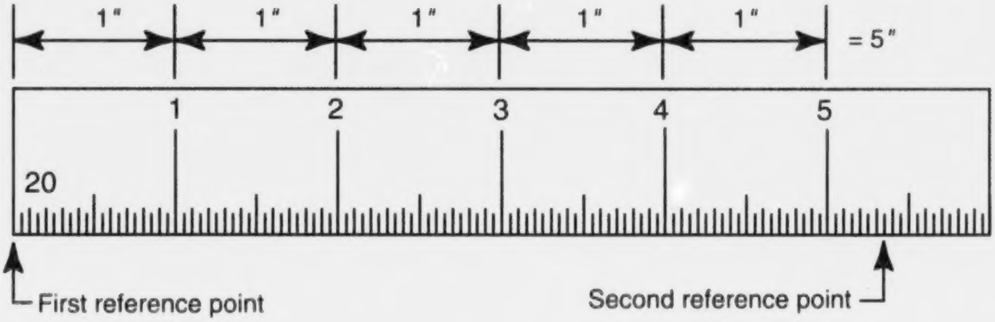
1. Align the end of the rule with one reference point.

2. Determine the number of whole units between the end of the rule and the second reference point.

Note: The rule illustrated in Figure 6 on the next page is graduated in twentieths of an inch.

Assignment Sheet 1

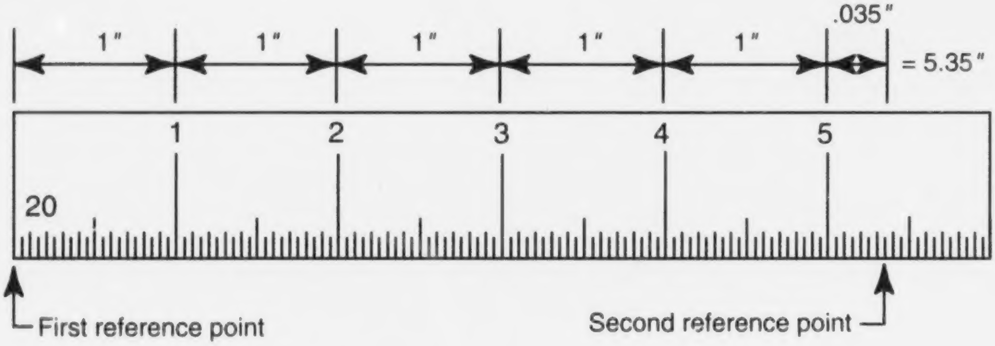
Figure 6



3. Count the number of graduations (twentieths, 0.05 inch) between the last whole unit and the second reference point.

4. Add this decimal fraction to the number of whole units counted earlier (see Figure 7).

Figure 7



Assignment Sheet 1

Reading a metric rule

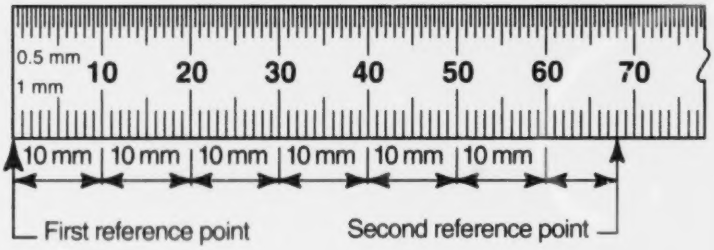
Note: Metric steel rules are available in a range from 150 millimeters to 1000 millimeters (1 meter) in length. The smallest graduation is 0.5 millimeter.

1. Align the end of the rule with one reference point.

2. Determine the number of whole units between the end of the rule and the second reference point.

   Note: The enlarged rule illustrated in Figure 8 is graduated in half millimeters (0.5) on the top and whole millimeters (1 mm) on the bottom scale.

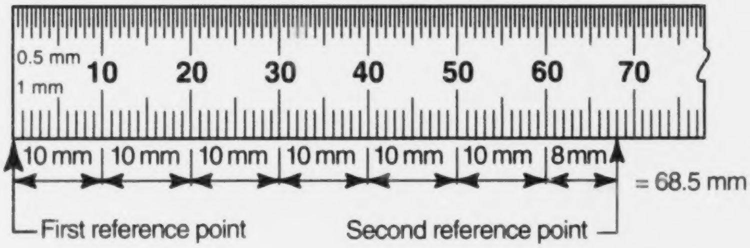
   Figure 8



3. Count the number of graduations (single and half millimeters) between the last whole unit and the second reference point.

4. Add this number to the number of whole units counted earlier (see Figure 9).

   Figure 9



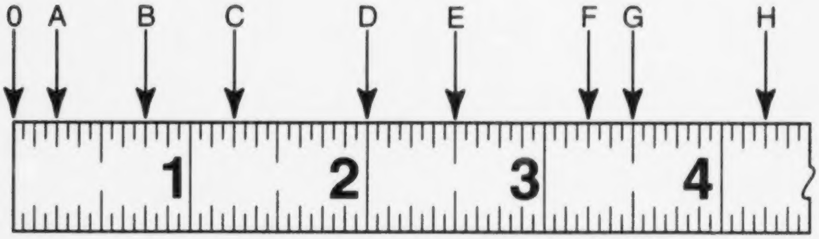
Assignment Sheet 1

Exercise

Directions: This assignment sheet is divided into three parts. Read each part, and then, answer the questions in each part.

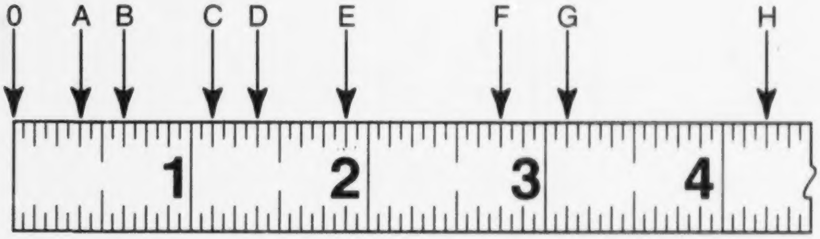
Part A

1. Read the U.S. customary rule illustrated below to the nearest quarter inch. Write your answers on the blanks provided.



a. 0 to A = ______________
b. A to B = ______________
c. 0 to C = ______________
d. A to D = ______________
e. B to D = ______________
f. 0 to E = ______________
g. C to E = ______________
h. B to F = ______________
i. D to G = ______________
j. A to H = ______________

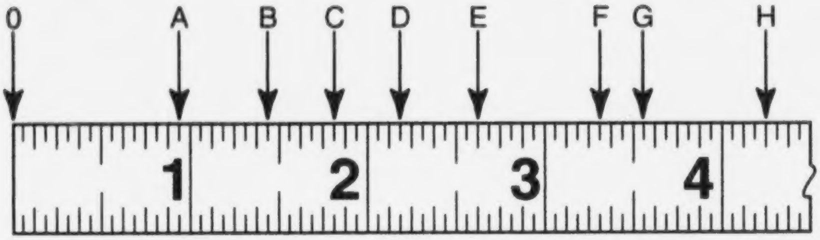
2. Read the U.S. customary rule illustrated below to the nearest eighth inch. Write your answers on the blanks provided.



a. 0 to A = ______________
b. A to B = ______________
c. 0 to C = ______________
d. B to D = ______________
e. A to E = ______________
f. 0 to F = ______________
g. D to E = ______________
h. C to G = ______________
i. 0 to H = ______________
j. E to H = ______________

Assignment Sheet 1

3. Read the U.S. customary rule illustrated below to the nearest sixteenth inch. Write your answers on the blanks provided.



a. 0 to A = ______________

b. A to B = ______________

c. 0 to C = ______________

d. B to D = ______________

e. A to E = ______________

f. 0 to F = ______________

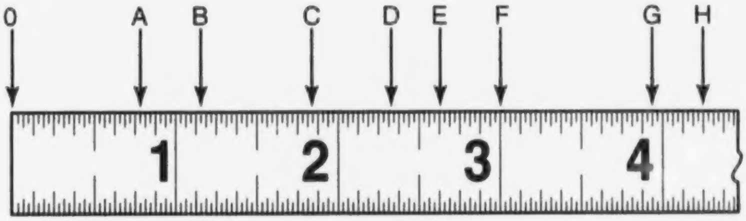
g. C to F = ______________

h. A to G = ______________

i. 0 to H = ______________

j. E to H = ______________

4. Read the U.S. customary rule illustrated below to the nearest one thirty-second of an inch. Write your answers on the blanks provided.



a. 0 to A = ______________

b. 0 to B = ______________

c. A to B = ______________

d. 0 to C = ______________

e. A to D = ______________

f. B to E = ______________

g. C to F = ______________

h. B to G = ______________

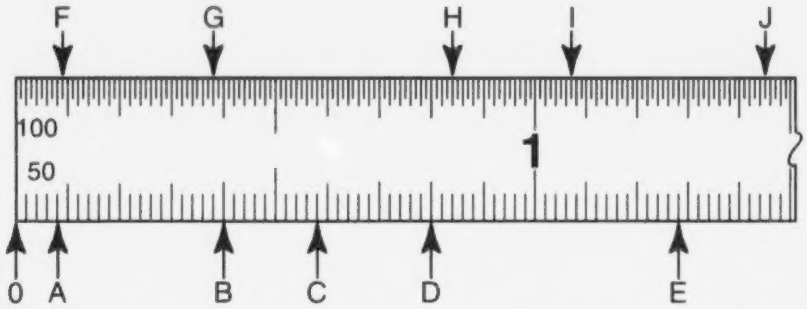
i. 0 to H = ______________

j. D to H = ______________

Assignment Sheet 1

Part B

1. Read the U.S. customary rule with decimal graduations in fiftieths and hundredths shown below. Write your answers on the blanks provided.



a. 0 to A = ______________ f. 0 to F = ______________

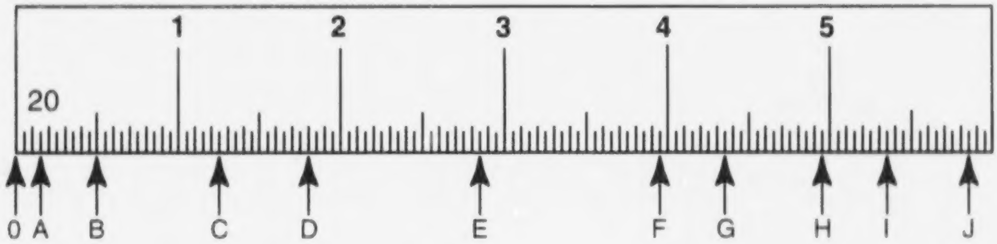
b. 0 to B = ______________ g. 0 to G = ______________

c. 0 to C = ______________ h. 0 to H = ______________

d. 0 to D = ______________ i. 0 to I = ______________

e. 0 to E = ______________ j. 0 to J = ______________

2. Read the U.S. customary rule with decimal graduations in twentieths shown below. Write your answers on the blanks provided.



a. 0 to A = ______________ f. 0 to F = ______________

b. 0 to B = ______________ g. 0 to G = ______________

c. 0 to C = ______________ h. 0 to H = ______________

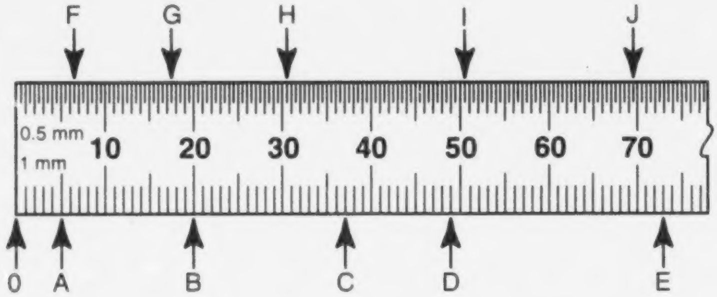
d. 0 to D = ______________ i. 0 to I = ______________

e. 0 to E = ______________ j. 0 to J = ______________

Assignment Sheet 1

Part C

Read the enlarged metric rule with 1-millimeter and 0.5-millimeter graduations shown below. Write your answers on the blanks provided.



1. 0 to A = ______________
2. 0 to B = ______________
3. 0 to C = ______________
4. 0 to D = ______________
5. 0 to E = ______________
6. 0 to F = ______________
7. 0 to G = ______________
8. 0 to H = ______________
9. 0 to I = ______________
10. 0 to J = ______________

Metric Measurement for Plumbers
Unit 5-C

Assignment Sheet 2—Convert English System Measurements to Metric Measurements

Name ____________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Directions have been followed	______
• Minimum of 85% of the questions have been answered correctly	______
• Assignment is neat and legible	______

Introduction: As the adoption of the metric system continues to impact U.S. industry, it is important for employees to have the necessary skills to convert measurements from English to metric. Converting units from one system to another is not easy, but can be mastered through practice. In this assignment, you will apply the formulas presented in objectives 3–8 to convert U.S. customary measurements to metric measurements.

Part A

Directions: Convert pipe sizes from inches to millimeters (mm), then give the appropriate pipe size. Show your work.

Example: 2″ = 2 x 25.4 = 50.8 mm = 50 mm pipe

1. 1 1/4″ diameter = ________ mm = ________ mm pipe

2. 3″ diameter = ________ mm = ________ mm pipe

3. 4 1/2″ diameter = ________ mm = ________ mm pipe

4. 6″ diameter = ________ mm = ________ mm pipe

Assignment Sheet 2

5. $^1/_2$″ diameter = ________ mm = ________ mm pipe

6. 8″ diameter = ________ mm = ________ mm pipe

Part B

Directions: Convert Fahrenheit (F) to Celsius (C). Show your work.

Example: 212°F - 32 = 180 ÷ 1.8 = 100°C

1. 100°F = ________ C
4. 0°F = ________ C
2. 210°F = ________ C
5. 65°F = ________ C
3. -10°F = ________ C
6. 25°F = ______ C

Part C

Directions: Convert liquid measurements from quarts and gallons to liters. Round to the nearest tenth. Show your work.

Examples: 4 quarts = 4 x 0.946 = 3.784 = 3.8 liters
5 gallons = 5 x 3.785 = 18.925 liters = 18.9 liters

1. 3 quarts = ______ l
4. 4 gallons = ______ l
2. 10 quarts = ______ l
5. 10 gallons = ______ l
3. 15 quarts = ______ l
6. 12 gallons = ______ l

Assignment Sheet 2

Part D

Directions: Convert weight measurements from pounds (lbs) to kilograms (kg). Round to the nearest whole number. Show your work.

Example: 20 lbs. = 20 x 0.4539 = 9.0780 = 9 kg

1. 25 lb. wall hung lavatory = ________ kg
2. 95 lb. water closet = ____________ kg
3. 250 lb. cast iron bathtub = ________ kg
4. 5 lb. cast iron floor drain = __________ kg
5. 45 lb. stainless steel sink = __________ kg
6. 120 lb. fiberglass shower stall = ______ kg

Part E

Directions: Calculate the area and volume for the following items using the formulas given in Objective 7. Show your work.

1. Area of a rectangular bathtub 6′ long, 3′ wide, and 2′ high
2. Volume of a rectangular bathtub 6′ long, 3′ wide, and 2′ high
3. Volume of a kitchen sink 12″ wide, 24″ long, and 8″ deep
4. Area of a circle with a 2′ radius
5. Volume of a cylinder with a 2′ radius and 4′ high

6. Volume of a cylinder with a 4′ radius and 8′ high

Part F

Directions: Convert cubic feet and inches to gallons. Show your work.

Examples: 6 cubic feet = 6 x 7.48 = 44.88 gallons
400 cubic inches = $^{400}/_{231}$ = 1.73 gallons

1. 5 cu. ft. = ________ gal
2. 14 cu. ft. = ________ gal
3. 27 cu. ft. = ________ gal
4. 12 cu. in. = ________ gal.
5. 29 cu. in. = ________ gal.
6. 37 cu. in. = ________ gal.

Part G

Directions: Solve the problems below by converting the English units to metric units. Show your work.

1. How many millimeters is a 2″ diameter pipe (approximately)?

2. How long in meters is a 10′ length of copper pipe?

3. What is the Celsius equivalent of 45°F?

4. How many liters are in a 2-gallon gas can?

Assignment Sheet 2

5. How many kilograms does a 25 lb. stainless steel sink weigh?

6. How many liters of water are in a 2 quart can?

7. How many millimeters is a 1/2" diameter pipe (approximately)?

8. What is the Celsius equivalent of 75°F?

Drainage Systems
Unit 1-D

Objective Sheet

Unit Objective

After completing this unit, the student should be able to install various parts of the drainage system, rough-in waste lines and vents, and secure lines of pipe with hangers. The student should demonstrate these competencies by completing the assignment sheets and job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to drainage systems with their definitions.
2. Identify soil, waste, and vent pipes in a drainage system.
3. Distinguish between materials used in soil and waste pipes.
4. State the functions of soil, waste, and vent pipes in a drainage system.
5. State purposes of plumbing traps.
6. Select types of traps.
7. Identify various types of pipe hangers, clamps, and supports.
8. Match pipe hangers, clamps, and supports with their uses.
9. Distinguish between the location, materials, and functions of building sewers and storm drains.
10. Select true statements concerning the installation of building sewers and storm drains.
11. List steps used when adding new plumbing to an old system during the planning and roughing-in stages.
12. Select true statements concerning the water and air methods of testing drainage systems for leaks.
13. Complete statements concerning trenching techniques.
14. Match shoring materials and devices with their definitions.
15. List safety precautions for various trenching hazards.
16. Label a cross section of a P-trap. (Assignment Sheet 1)
17. Identify fittings on a drainage system. (Assignment Sheet 2)
18. Secure a permit for the installation of a plumbing system. (Assignment Sheet 3)

Objective Sheet

19. Install a bathtub waste and overflow and trap on a two-story building. (Job Sheet 1)

20. Install a prefabricated shower base drain (caulked method). (Job Sheet 2)

21. Lay out trench lines. (Job Sheet 3)

22. Calculate the slope required for building sewer lines. (Job Sheet 4)

23. Install drain pipe in trenches. (Job Sheet 5)

24. Install storm drains. (Job Sheet 6)

25. Backfill trenches. (Job Sheet 7)

26. Install pipe sleeves or thimbles through walls, ceilings, or floors. (Job Sheet 8)

27. Install soil or waste back vents. (Job Sheet 9)

28. Install cleanouts on drains. (Job Sheet 10)

29. Rough-in waste lines and vents for built-in lavatories. (Job Sheet 11)

30. Rough-in waste lines and vents for bathtubs. (Job Sheet 12)

31. Secure horizontal and vertical lines of pipe to masonry surfaces with hangers. (Job Sheet 13)

32. Secure horizontal and vertical lines of pipe to wood surfaces with hangers. (Job Sheet 14)

33. Secure horizontal and vertical lines of pipe to metal surfaces with hangers. (Job Sheet 15)

34. Install vent terminals (roof flashing). (Job Sheet 16)

35. Inspect a plumbing system. (Job Sheet 17)

Drainage Systems
Unit 1-D

Information Sheet

1. **Terms and definitions**

   a. **Cleanout**—Access point to drain or trap for the purpose of removing obstructions

   b. **Drain pipe**—Pipe which carries waste water

   c. **DWV**—Drain, waste, and vent

   d. **Flashing**—Shield that fits over vent pipe on roof to prevent water from entering house through roof opening

   e. **Pitch**—Slope or grade given to a horizontal run of pipe to permit gravity flow of liquid

   f. **Rough-in**—Initial stages of plumbing installation which include bringing the water and sewer lines into the building and topping out or installing all pipes which will be enclosed in the walls

   g. **Siphoning**—Creating a partial vacuum in a pipe so that water can be drawn into it

   Note: Traps can be emptied if vacuum is not reduced by venting.

   h. **Soil pipe**—Pipe which conveys sewage containing fecal matter to the building drain or building sewer

   i. **Soil stack**—Pipe which connects water closets to building drain and extends up and out of house roof to serve as a vent

   j. **Vent pipe**—Part of the vent system which provides air to and from the drainage system and which protects trap seals from siphonage and back pressure

   k. **Vent stack**—The vertical extension of the drainage system through the roof and all that piping above the highest horizontal drain connected to the stack

   l. **Waste pipe**—Pipe which conveys only the discharge which does not contain fecal matter

2. **Soil, waste, and vent pipes in a drainage system**

   Note: Refer to Student Supplement 1 in this unit.

   a. Soil pipes

   Note: Soil pipes extend from the house sewer (5′ maximum outside of building) to highest branch connected to water closets.

   - Building drain
   - Soil stack

Information Sheet

b. Waste pipes

Note: Waste pipes extend from the main soil or vent stack to the fixture traps.

- Building drain branch
- Waste stack
- Horizontal branch
- Fixture drain

c. Vent pipes

Note: Every fixture must be vented; therefore, vent pipes extend from the fixture to the main vent stack or go directly through the roof to the atmosphere.

- Vent stack
- Stack vent
- Individual vent
- Branch vent
- Wet vents

d. Other pipes and materials

- City sewer
- Building sewer
- Cleanout
- Stack cleanout
- Fixture trap
- Roof flashing

3. Materials used in soil and waste pipes

a. Soil pipes

Note: The minimum size for soil pipe is 3″.

- Cast iron
- Copper
- Plastic

Information Sheet

b. Waste pipes

Note: The minimum size for waste pipe is 1 1/4″.

- Copper
- Plastic
- Galvanized steel
- Cast iron

4. **Functions of soil, waste, and vent pipes in a drainage system**

   a. **Soil pipes**—Carry drainage which includes fecal matter (toilet discharge)

   b. **Waste pipes**—Carry liquid waste which does not contain fecal matter (toilet discharge)

   c. **Vent pipes**

   - Allow free air to circulate in the system as the "vent" or terminal is open to the atmosphere above the building roof
   - Provide equalization of air pressure on both sides of the fixture trap, thus preventing the siphoning of the trap
   - Minimize back pressure on trap seals, thus preventing loss of seal

5. **Purposes of plumbing traps**

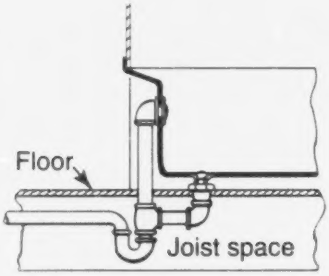
   a. Provide a liquid seal which will prevent the back passage of air without affecting the flow of sewage or waste water through it

   b. Prevent sewer gas from entering the building through the fixture

   c. Prevent vermin from entering the building through the fixture

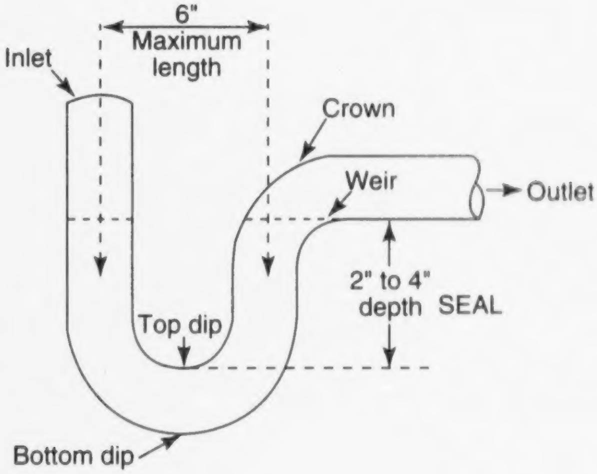
6. **Types of traps**

   a. P-trap



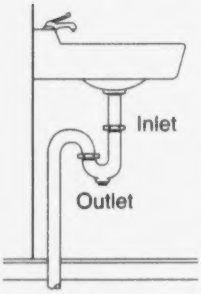
P-Trap installed on bathtub drain

Information Sheet



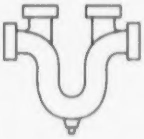
Parts of a P-trap

b. S-trap

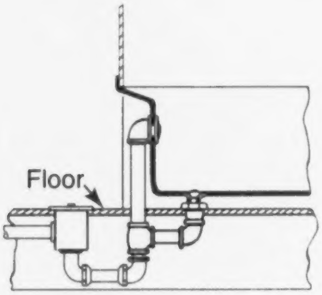


Note: The S-trap is illegal.

c. Running trap



d. Drum trap

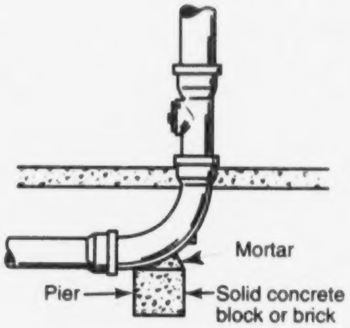


Note: The drum trap is prohibited except where specifically approved. Check local codes.

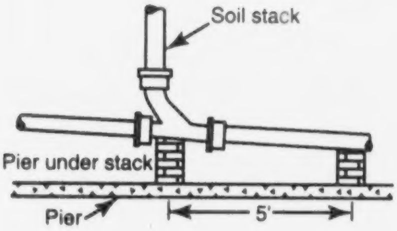
Information Sheet

7. Types of pipe hangers, clamps and supports

a. Piers

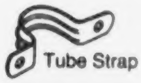


Underground stack base support

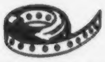


Note: Piers should be made of masonry or other material that will not deteriorate easily.

b. Straps

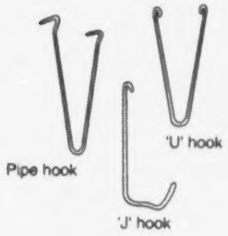


Tube Strap

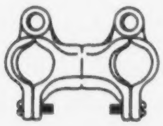


Perforated band iron

c. Hooks



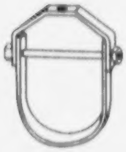
d. Pipe clamp



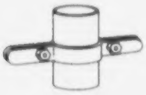
Split pipe clamps back to back

Information Sheet

e. Clevis hanger



f. Riser clamp



8. **Uses of pipe hangers, clamps, and supports**

    a. **Pier**—Supports base of stack and horizontal runs of large pipe near floor or ground level

    b. **Strap**—Supports small size pipes by attaching to walls, beams, and ceilings

    c. **Pipe hook**—Supports small to medium size pipes to wooden beams and joists

    d. **Pipe clamp**—Supports small to medium size pipes to any kind of ceiling or wall structure

    e. **Clevis hanger**—Supports medium to large size pipes to ceiling or wall structure

    f. **Riser clamp**—Supports stacks and other large pipe when additional vertical support is needed

    Note: Pipes should not be used as structural supports.

9. **Location, materials, and functions of building sewers and storm drains**

    a. Building sewers

    - Location—Between building drain and sewer main (or septic tank)
    - Materials
        - — Cast iron
        - — PVC
        - — Vitrified clay (and locally approved material)
    - Function—To carry sewage from the building to the sewer main

Information Sheet

b. Storm drains

- Location—In, under, and/or outside building
- Materials
  - — Cast iron
  - — Vitrified clay
  - — Plastic
  - — Galvanized steel

  Note: Sheet metal is used for leaders, gutters, etc.

- Function—To carry off rain water and other uncontaminated water in a system independent of the sewage system

10. Installation of building sewers and storm drains

Note: Check with local codes.

a. Building sewers

- Excavation of trench should be clean and neat.
- Pipe should be laid alongside trench for easy access.
- Trench should be graded or given pitch to allow for gravity drainage of sewer pipe.

  Note: 1/8" per foot is sufficient for sewer pipe.

- In some instances, a "lateral" is provided by the city and the plumber must first establish the actual depth of this lateral.

  Note: If a lateral is not provided by the city, the plumber is often required to make the connection to the main sewer.

b. Storm drains

- Usually not trapped
- Extended drain pipe might be perforated to disperse water into ground.
- Drain pipe might empty into:
  - — Dry well
  - — Lake, pond, or stream
- Drain pipes around foundations are perforated to collect and carry seepage water away from building.

Information Sheet

11. Adding new plumbing to an old system

a. Planning

- Check local plumbing code.
- Determine location and design.
- Determine availability of existing plumbing.
- Develop materials list.

Note: It is extremely important to plan ahead and have the proper fittings for cutting into the system.

b. Roughing-in the drainage

- Determine layout of new fixtures.
- Cut out access holes and openings for new pipe installation.

Caution: Care must be taken to avoid weakening building structure.

- Cut into the existing drainage system.

Caution: Fires are a constant hazard in addition work and remodeling.

- Install drainage pipes.

Note: Follow local codes for pipe sizing, venting, and local ordinances.

c. Roughing-in water distribution pipes

- Cut into existing water system.

Note: The end, or terminal point, of the water system might not be of sufficient size to supply the new addition.

- Cut and/or drill access holes and openings for new pipe installation.
- Install water distribution pipes.

Note: Test for leaks before enclosing pipes in floors or walls.

Information Sheet

12. Water and air methods of testing drainage systems for leaks

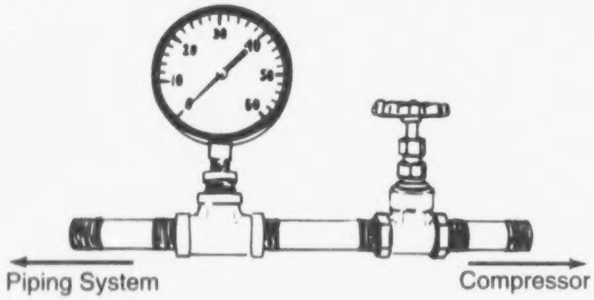
Note: Both types of tests can be done on the entire system or sections of the system. Check local codes.

a. Water

- If entire system is tested, fill the system until water overflows the vent stack above the roof.
- If sections of the system are tested, a 10′ head must be applied to the tested section.
- Allow water to remain in system for 15 minutes prior to the test.
- Visually inspect all joints of the tested system.
- If no leaks are found, the system is tight at all joints.

b. Air

- Attach air compressor testing apparatus to any suitable opening.



- Close all other inlets and outlets.
- Test system by maintaining 5 psi pressure for 15 minutes.

  Note: Leaks can be detected by sound, soap and water, or by some odor injected into the system. Some cases may require a final test of the system by putting 2 ounces of oil of peppermint in the system. Smoke tests are also used as a final test. This is done by filling all traps with water, producing smoke by a smoke machine, and sealing the vent terminal. A pressure equivalent to 1″ water column must be maintained for 15 minutes.

13. Trenching techniques

a. Open trenching

- Angle of repose must be adequate.
- Angle required depends on type of soil.
- Demands careful attention to slope.
- Open trenching is acceptable only when soil type and space permit a safe angle of repose.

Information Sheet

b. Shored trenching

- Always use proper shoring in potentially dangerous excavations.
- Federal (OSHA) standards require shoring where excavation walls exceed a depth of 4′, and trenches must have a ladder for every 25′ of lateral.

14. Shoring materials and devices

a. Materials

- Timber bracing—Wooden stanchions placed at intervals and supported by wooden braces
- Light timber sheeting—Continuous, tightly arranged wooden stanchions held by wooden cross members
- Sheet piling—A pile or sheeting that forms a continuous support wall, or a row of timber, concrete, or steel piling driven to assure a tight supporting wall against earth pressure

b. Devices

- Trench box—A continuous supportive box of wood and/or metallic supports to retain the earth
- Hydraulic shores—Hydraulic jacks, usually made of aluminum, activated by a hydraulic pump
- Screw jacks—Metallic screw devices with foot supports on both edges; they hold timbers or boards against the trench face

15. Safety precautions for trenching hazards

a. Materials and tools falling into the trench

- Place all pipes or tools used on the job at least two feet from the edge of a trench.
- All workers should wear hard hats to protect themselves from devices or tools accidentally dropped in the trench.
- Hand pipe carefully into a trench; do not drop or roll it.
- Two or more workers should handle heavy tools and pipe to avoid their getting out of control.
- Move pipe and equipment only as required.
- Never stack materials by the edge of a trench or any excavation.

b. Excavated debris falling into the trench

- Place earth, rocks, or other materials removed from the trench at least two feet from the edge.
- Avoid piling excavated materials too high since this could overload the trench wall and create a potential cave in.

Information Sheet

c. Machinery falling into an excavation

- Beware of operating equipment at all times and maintain a safe distance.
- If operating equipment vibrates excessively, notify a foreman; this vibration could be transmitted through soil to the trench wall and cause a cave in.
- Note any careless or unskilled machine operators and ask the appropriate foreman to correct the situation.

d. Debris falling from working machinery

- Wear a hard hat for all trenching operations.
- Wear goggles anytime there is a potential for flying debris.

e. Machinery hitting power or utility lines

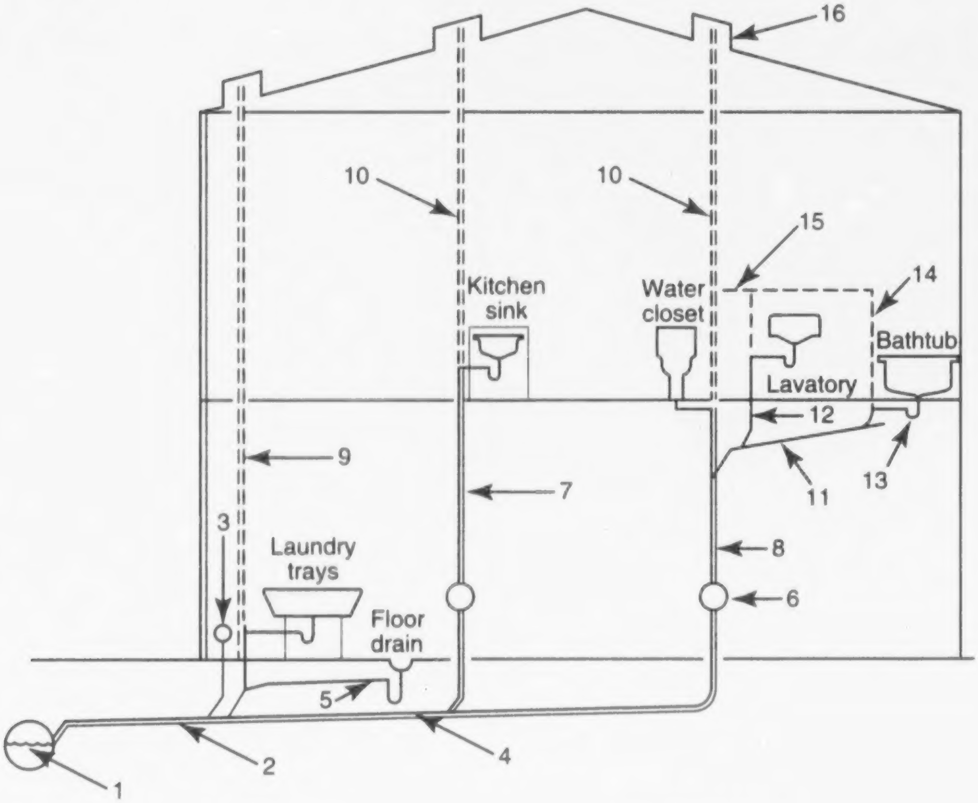
- Locate and mark underground obstacles: water, gas, telephone, electric, and steam lines; storm drains; sprinklers; and other equipment piping.
- Locate and mark overhead obstacles: power, lighting, and telephone lines; trees; and manmade obstacles.

f. People falling into an open trench

- Secure the job site at all times, especially at night, keeping in mind that curious children see job sites as interesting playgrounds.
- Cover all open trenches with timber or plywood strong enough to support a reasonable amount of weight.
- Position the protective sheathing so it will not only protect the public from danger but also shield the trench from rain water.
- Reflective barricades and lights around the trench add additional protection for both curious passersby and animals.

Drainage Systems
Unit 1-D

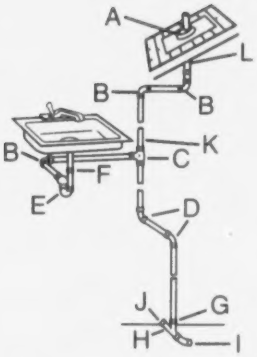
Student Supplement 1—Soil, Waste, and Vent Pipes



1. City Sewer
2. Building Sewer
3. Cleanout
4. Building Drain (Soil pipe)
5. Building Drain Branch (Waste pipe)
6. Stack Cleanout
7. Waste Stack (Waste pipe)
8. Soil Stack (Soil pipe)
9. Vent Stack (Vent pipe)
10. Stack Vent (Vent pipe)
11. Horizontal Branch (Waste pipe)
12. Fixture Drain (Waste pipe)
13. Fixture Trap
14. Individual Vent (Vent pipe)
15. Branch Vent
16. Roof Flashing

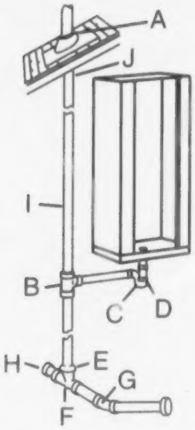
Student Supplement 1

Kitchen Sink Only



CODE	DESCRIPTION	SIZE	QTY
A	Roof Flashing	1 ½″	1
B	90° Elbows	1 ½″	3
C	Sanitary Tee	1 ½″	1
D	45° Elbows	1 ½″	2
E	"P" Trap	1 ½″	1
F	Trap Adapter	1 ½″	1
G	PVC Bushing	2″ x 1 ½″	1
H	PVC Sch. 40 "Y" Branch	2″	1
I	PVC Sch. 40 ⅛″ Bend	2″	1
J	Cleanout Ferrule	2″	1
K	Plastic Pipe—PVC Sch. 40	1 ½″	20 Ft.
L	Plastic Pipe	2″	10 Ft.

Shower Only



CODE	DESCRIPTION	SIZE	QTY
A	Roof Flashing	2″	1
B	Sanitary Tee	1 ½″	1
C	"P" Trap	1 ½″	1
D	Trap Adapter	1 ½″	1
E	Plastic Bushing	1 ½″	1
F	PVC Sch. 40 "Y" Branch	2	1
G	PVC Sch. 40 ⅛″ Bend	2″	1
H	Cleanout Ferrule	2″	1
I	Plastic Pipe	1 ½″	20 Ft.
J	Plastic Pipe	2″	10 Ft.

Drainage Systems
Unit 1-D

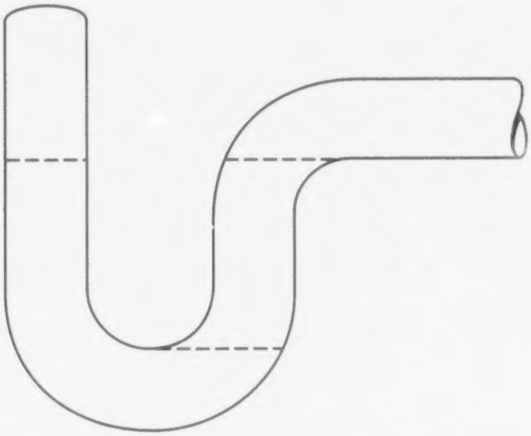
Assignment Sheet 1—Label a Cross Section of a P-Trap

Name ______________________ Overall Rating ____________

Evaluation Criteria	Rating
• Directions are followed	______
• Answers are correct	______
• Assignment is neat and completed on time	______

Directions: Label the following parts on the cross section of a P-trap on the illustration below.

1. Inlet
2. Outlet
3. Seal
4. Crown weir
5. Top dip
6. Bottom dip



Drainage Systems
Unit 1-D

Assignment Sheet 2—Identify Fittings on a Drainage System

Name ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Directions are followed	______
• Local code is followed	______
• Answers are correct	______
• Assignment is neat and completed on time	______

Directions: Identify all the fittings on the following illustration of a drainage system.

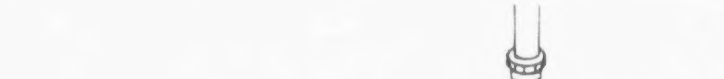
Note: Use local code.

A. ____________ B. ____________ C. ____________

D. ____________ E. ____________ F. ____________

G. ____________ H. ____________ I. ____________

J. ____________ K. ____________ L. ____________



Drainage Systems
Unit 1-D

Assignment Sheet 3—Secure a Permit for the Installation of a Plumbing System

Name ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Completed application for permit correctly	______
• Secured a plumbing installation permit	______

Directions: Complete an application for a permit to install a plumbing system. Ask your instructor for a plumber's license number and information concerning a plumbing installation, including the location where work is to be done, and application codes.

A. Materials

- Application for permit
- Code book
- Pencil

B. Procedure

☐ 1. Study the information concerning a plumbing installation.

☐ 2. Draw appropriate sketches.

☐ 3. Check with instructor for proper procedure for submitting application.

☐ 4. Secure permit.

☐ 5. Ask your instructor to check your work.

Drainage Systems
Unit 1-D

Job Sheet 1—Install a Bathtub Waste and Overflow and Trap on a on a Two-Story Building

Name ______________________________ Attempt Number ______________

Date ______________________________ Overall Rating ______________

Evaluation Criteria	**Rating**
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Hand saw and pocket knife
- Adjustable pliers (channel locks)
- Plug wrench
- Phillips head screwdriver
- Straight screwdriver
- Small adjustable wrench
- PVC solvent cement
- PVC solvent cleaner
- Pipe compound
- 6′ stepladder
- Proper materials, such as tub waste and overflow and trap

B. Procedure

☐ 1. Check the tub waste and overflow and trap for missing parts.

☐ 2. Loosely assemble tub waste and overflow, but exclude trip lever, trip lever cover, and tub drain.

Note: A small amount of pipe compound on the threads allows easy tightening.

☐ 3. Place tub waste in place and adjust horizontal drain pipe (shoe); cut if necessary.

Note: Make sure beveled gasket is in position behind tub on overflow.

☐ 4. Apply putty under tub drain flange and connect drain while holding tub waste and overflow in position and tighten with plug wrench.

Note: Make sure washer under tub is in correct position.

Job Sheet 1

☐ 5. Install trip lever, lever cover, and drain strainer.

Note: When final test is made, trip lever should be adjusted to assure complete operation.

☐ 6. Prepare tools and materials on floor lever below tub.

☐ 7. Place and adjust stepladder under tub drain.

☐ 8. Determine correct length of tailpiece and waste pipe by holding assembled trap in position.

Note: It may be necessary to cut to correct length.

☐ 9. Prepare plastic connections for cementing.

☐ 10. Assemble trap in proper position and cement drain pipe onto trap outlet.

☐ 11. Tighten slip nut on tub drain pipe.

Note: Do not use pipe compound on slip nuts with rubber washer.

☐ 12. Test joints for leaks.

Note: These joints should be tested before ceiling is installed.

☐ 13. Ask your instructor to check your work.

☐ 14. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Drainage Systems
Unit 1-D

Job Sheet 2—Install a Prefabricated Shower Base Drain (Caulked Method)

Name ________________________ Attempt Number ____________

Date ________________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Correctly determined pipe height	______
• Properly cut and reamed pipe to correct height	______
• Properly caulked pipe	______
• Correctly placed strainer on drain	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Pipe cutter with reamer
- Caulking irons
- Yarning irons
- Furnace, lead pot, lead
- Ladle
- Oakum

B. Procedure

☐ 1. Determine if shower waste pipe has been properly located.

Note: The waste pipe should extend above the floor several inches and at least 1″ more than is needed

☐ 2. Determine correct height of waste pipe in relation to shower base.

☐ 3. Cut and ream waste pipe to correct height.

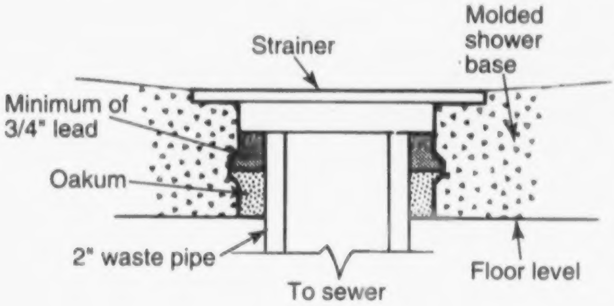
☐ 4. Place shower base in proper position over waste pipe.

☐ 5. Caulk the waste pipe into the shower base drain opening.

Job Sheet 2

☐ 6. Place shower base strainer firmly on drain (Figure 1).

FIGURE 1



☐ 7. Ask your instructor to check your work.

☐ 8. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ____________________

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Drainage Systems
Unit 1-D

Job Sheet 3—Lay Out Trench Lines

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Laid out trench lines level and straight	______
• Laid out trench lines the correct width apart	______
• Planted stakes properly	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria. Trench lines must be level, straight, and the correct width apart.

A. Equipment and materials

- 6′ rule or steel tape
- Wooden stakes
- Hammer
- Roll of string
- Blueprints

B. Procedure

☐ 1. Determine location of trench.

☐ 2. Locate trench end points.

☐ 3. Determine trench width and centerline.

☐ 4. Drive two stakes (one on each side) 2″ from end of trench equidistant from centerline and maintain trench width.

Note: The inside of each stake should be on the outside edge of an extended trench line.

☐ 5. Repeat step 4 for other end of trench.

☐ 6. Attach string to inside edge of one stake, stretch taut to inside edge of stake at opposite end of trench on same side, and tie securely (level).

☐ 7. Repeat step 6 for other side of trench.

Job Sheet 3

☐ 8. Ask your instructor to check your work.

☐ 9. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Drainage Systems
Unit 1-D

Job Sheet 4—Calculate the Slope Required for Building Sewer Lines

Name ____________________ Attempt Number __________

Date ____________________ Overall Rating __________

Evaluation Criteria	Rating
• Maintained correct slope tolerance	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria. Slope tolerance will be a minimum of 1/8" per foot.

A. Equipment and materials

- Transit level and tripod
- Pencil and paper
- Blueprint

B. Procedure

☐ 1. Locate point where building sewer will join main sewer.

☐ 2. Set tripod on top of main sewer pipe; establish grade at this point.

☐ 3. Establish grade on sewer pipe stubbed out of building.

Note: The difference between grades established at the main sewer and the building sewer is the slope required for building the sewer line.

☐ 4. Ask your instructor to check your work.

☐ 5. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ____

Drainage Systems
Unit 1-D

Job Sheet 5—Install Drain Pipe in Trenches

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Maintained correct minimum grade	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria. The minimum grade of the pipe will be 1/8″ per foot.

A. Equipment and materials

- Pointed shovel
- 6′ rule or steel tape
- Nylon line
- Wooden stakes
- Level
- Oakum
- Yarning iron
- Tar compound
- Putty knife
- Test plug
- Water (for test)

B. Procedure

☐ 1. Determine length of sewer line.

☐ 2. Determine if minimum fall from end to end is 1/8″ per foot.

☐ 3. Establish average grade line from end to end.

☐ 4. Lay out trench with nylon line and stakes.

☐ 5. Dig trench to desired depth, maintaining average grade (minimum 1/8″ per foot).

☐ 6. Lay pipe in trench and check each length for minimum grade.

☐ 7. Join each section of pipe.

Job Sheet 5

☐ 8. Test for leaks.

☐ 9. Backfill trench.

☐ 10. Ask your instructor to check your work.

☐ 11. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Drainage Systems
Unit 1-D

Job Sheet 6—Install Storm Drains

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Blueprints
- Pipe
- Fittings
- Hangers
- Electric saw
- Roof drains

B. Procedure

☐ 1. Locate roof drain positions.

☐ 2. Determine piping size per roof area to be drained.

☐ 3. Cut and lay out piping components.

☐ 4. Install drain piping using appropriate hangers.

☐ 5. Cut holes in roof at designated locations.

☐ 6. Set drains and connect to piping.

☐ 7. Have your instructor check your work.

☐ 8. Clean up work area and return all tools and equipment to proper place.

Evaluator's Comments: ______________________________________

Drainage Systems
Unit 1-D

Job Sheet 7—Backfill Trenches

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Pointed shovel
- Tamp

B. Procedure

☐ 1. Carefully place a 6″ layer of loose dirt in trench and tamp until backfill is completed.

☐ 2. Compact backfill under and beside pipe for support.

☐ 3. Place 6″ layers of dirt in trench and tamp until backfill is completed.

☐ 4. Overfill trench about 3″ to allow for settling.

☐ 5. Have your instructor check your work.

☐ 6. Clean up area and return tools and equipment to proper place.

Evaluator's Comments: ______________________________

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Drainage Systems
Unit 1-D

Job Sheet 8—Install Pipe Sleeves or Thimbles Through Walls, Ceilings, or Floors

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	Rating
• Center point of vent pipe is correct distance from reference points	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Blueprint
- 3″ vent pipe
- Pencil
- 6′ rule or steel tape
- Tin snips
- Electric saw
- Hammer and nails
- Wire
- Pipe

B. Procedure

☐ 1. Using a blueprint, determine thimble center location on both sides of formed wall section.

☐ 2. Draw 3″ circle around thimble center location on both sides of forms.

☐ 3. Cut vent pipe to length equal to wall thickness.

☐ 4. Insert prepared vent pipe into space between wall forms and manipulate to desired location.

☐ 5. Drive in nails slightly inside and outside of circle lines to hold vent pipe in place.

☐ 6. Wrap and tighten wire around nails and pipe for stability.

☐ 7. Ask your instructor to check your work.

Job Sheet 8

☐ 8. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Drainage Systems
Unit 1-D

Job Sheet 9—Install Soil or Waste Back Vents

Name ______________________ Attempt Number ________

Date ______________________ Overall Rating ________

Evaluation Criteria	**Rating**
• Vent connection is 6" above flood level rim	______
• Joints are leak-proof	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Rough-in book
- 6′ rule or steel tape
- Handsaw and pocket knife
- PVC pipe
- PVC fittings
- PVC solvent cement
- PVC solvent cleaner
- Level
- Electric drilling machine
- Drills
- Safety glasses

B. Procedure

☐ 1. Determine height required for vent line.

☐ 2. Lay out piping and fittings for horizontal cross vent.

☐ 3. Assemble pipe sections.

☐ 4. Connect pipe sections from fixture drain to main vent or stack.

☐ 5. Check grade of horizontal pipe.

☐ 6. Ask your instructor to check your work.

Job Sheet 9

☐ 7. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Drainage Systems
Unit 1-D

Job Sheet 10—Install Cleanouts on Drains

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Cleanout terminates at an accessible point	______
• Cleanout opens in the direction of drainage flow or at right angle	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- 6′ rule or steel tape
- Pencil
- Blueprint
- Cast iron pipe cutters
- 4″ cast iron pipe
- 4″ fittings
- 4″ compression gasket
- Gasket lubricant
- 2″ x 4″ block
- Small sledge hammer

B. Procedure

☐ 1. Identify proper location of cleanout plug from construction plans.

☐ 2. Determine floor elevation or wall thickness.

☐ 3. Cut and install hub of drain pipe to accommodate cleanout.

☐ 4. Insert gasket in hub of drain pipe.

☐ 5. Lubricate inside of rubber gasket and outside of plug pipe.

☐ 6. Insert plug into drain hub and gasket.

☐ 7. Drive cleanout plug into drain hub and gasket, using a 2″ x 4″ block and hammer.

☐ 8. Ask your instructor to check your work.

Job Sheet 10

☐ 9. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Drainage Systems
Unit 1-D

Job Sheet 11—Rough-In Waste Lines and Vents for Built-In Lavatories

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Joints do not leak	
• Vent and drain lines are properly graded and installed	
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- 6′ rule or steel tape
- Pencil
- PVC couplings
- Hacksaw
- Electric saw
- Electric drilling machine with drills
- Hammer
- Chisel
- Nail puller
- PVC pipe
- PVC fittings
- 1 1/2″ roof flange

B. Procedure

☐ 1. Lay out waste line from main line to fixture.

☐ 2. Measure and cut piping for rough-in plumbing.

☐ 3. Assemble piping, using PVC couplings.

☐ 4. Attach 2″ x 1 1/2″ sanitary tee to assembly end.

☐ 5. Join 1 1/2″ PVC pipe, using sanitary tee for connection.

☐ 6. Align and support pipe.

☐ 7. Run vent line from soil pipe to revent line or through roof.

Job Sheet 11

☐ 8. Ask your instructor to check your work.

☐ 9. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Drainage Systems
Unit 1-D

Job Sheet 12—Rough-In Waste Lines and Vents for Bathtubs

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	Rating
• Vented waste line according to code	______
• Properly aligned and supported pipes	______
• Used proper pipe materials and fittings	______
• Joints did not leak when tested	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Rough-in book
- 6′ rule or steel tape
- PVC pipe
- Fittings
- Hand saw
- PVC cement and cleaner
- Pipe hangers
- Hammer
- Blueprints

B. Procedure

☐ 1. Take measurements from rough-in specifications.

☐ 2. Lay out waste line from main line or from foundation wall to fixture.

☐ 3. Cut pipe to length.

☐ 4. Assemble pipe, leaving cleanout and vent openings as necessary.

☐ 5. Align and support pipe.

☐ 6. Insert foam cup for waste line at tub drain if installing waste in concrete slab.

☐ 7. Run vent line from soil pipe to revent line or through roof.

Job Sheet 12

☐ 8. Have your instructor check your work.

☐ 9. Clean up the area and return all tools and equipment to proper place.

Evaluator's Comments: ______________________________

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Drainage Systems
Unit 1-D

Job Sheet 13—Secure Horizontal and Vertical Lines of Pipe to Masonry Surfaces With Hangers

Name ______________________________ Attempt Number ______________

Date ______________________________ Overall Rating ______________

Evaluation Criteria	**Rating**
• Selected correct hanger	______
• Installation complies with local codes	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Hangers
- Threaded rod
- Screws
- Bolts and nuts
- Safety glasses
- Molly bolts
- Hammer
- Electric drilling machine
- Drills
- Adjustable wrench
- Hacksaw

B. Procedure

☐ 1. Select pipe, position, and needed hanger.

☐ 2. Locate hanger points on surface.

☐ 3. Prepare surface, if needed.

☐ 4. Secure hanger or hanger section, whichever needed, to surface.

☐ 5. Attach hanger clamp portion to pipe, if needed.

☐ 6. Hoist pipe into position for hanger acceptance.

☐ 7. Secure pipe to hanger.

Job Sheet 13

☐ 8. Ask your instructor to check your work.

☐ 9. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

Drainage Systems
Unit 1-D

Job Sheet 14—Secure Horizontal and Vertical Lines of Pipe to Wood Surfaces With Hangers

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Selected correct hanger	______
• Installation complies with local codes	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Hangers
- Threaded rod
- Screws, lag bolts
- Bolts and nuts
- Safety glasses
- Hammer
- Screwdriver
- Adjustable wrench
- Electric drilling machine
- Drills
- Hacksaw
- Pipe

B. Procedure

☐ 1. Select pipe, position, and needed hanger.

☐ 2. Locate hanger points on surface.

☐ 3. Prepare surface, if needed.

☐ 4. Secure hanger or hanger section, whichever needed, to surface.

☐ 5. Attach hanger clamp portion to pipe, if needed.

☐ 6. Hoist pipe into position for hanger acceptance.

☐ 7. Secure pipe to hanger.

Job Sheet 14

☐ 8. Ask your instructor to check your work.

☐ 9. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

Drainage Systems
Unit 1-D

Job Sheet 15—Secure Horizontal and Vertical Lines of Pipe to Metal Surfaces With Hangers

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Selected correct hangers	______
• Installation complies with local codes	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Hangers
- Threaded rod
- Screws
- Bolts and nuts
- Safety glasses
- Molly bolts
- Clamps
- Hammer
- Adjustable wrench
- Electric drilling machine
- Drills
- Hacksaw
- Pipe

B. Procedure

☐ 1. Select pipe, position, and needed hanger.

☐ 2. Locate hanger points on surface.

☐ 3. Prepare surface, if needed.

☐ 4. Secure hanger or hanger section, whichever needed, to surface.

☐ 5. Attach hanger clamp portion to pipe, if needed.

☐ 6. Hoist pipe into position for hanger acceptance.

Job Sheet 15

☐ 7. Secure pipe to hanger.

☐ 8. Ask your instructor to check your work.

☐ 9. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Drainage Systems
Unit 1-D

Job Sheet 16—Install Vent Terminals (Roof Flashing)

Name ______________________________ Attempt Number ____________

Date ______________________________ Overall Rating ____________

Evaluation Criteria	Rating
• Terminal is watertight	_______
• Demonstrated proper safety precautions	_______
• Demonstrated correct use of tools and materials	_______
• Demonstrated quality of workmanship	_______
• Completed job neatly and on time	_______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Lead hammer
- Vent terminal (roof flashing)
- Tar compound
- Putty knife

B. Procedure

☐ 1. Select vent terminal to match pitch of roof.

☐ 2. Slip vent terminal over vent pipe extending through roof.

☐ 3. Depending on type of vent terminal, bend terminal top over vent pipe, or beat lead top of terminal into cast-iron vent pipe to seal terminal.

☐ 4. Seal flashing with tar compound.

☐ 5. Have your instructor check your work.

☐ 6. Clean up the area and return all tools and equipment to proper place.

Evaluator's Comments: ______________________________

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Drainage Systems
Unit 1-D

Job Sheet 17—Inspect a Plumbing System

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Report clear and legible	______
• Findings correspond with building inspector's findings	______
• Completed job on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Copy of contract
- Code book
- Pencil
- Notebook

B. Procedure

☐ 1. Read the contract, especially the specifications.

☐ 2. Inspect the piping.

☐ 3. Check code book for compliance.

☐ 4. Write positive or negative report on inspection.

Note: Be able to relate negative reports to code book regulation.

☐ 5. Ask your instructor to check your work.

Evaluator's Comments: ______________________________

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Water Systems
Unit 2-D

Objective Sheet

Unit Objective

After completing this unit, the student should be able to rough-in water supply lines for bathtubs, water closets, and water heaters, and test water pressure on water supply systems. The student should demonstrate these competencies by completing the assignment sheets and job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to residential water systems with their definitions.
2. Match the components of a water system in a single-family dwelling with their functions.
3. Select factors to consider when installing a hot water system.
4. Select true statements about sizing of pipes in residential water systems.
5. Distinguish between materials used for pipes and materials used for valves in water pipe systems.
6. Select true statements about the prevention of frozen pipes in cold weather.
7. List methods of preventing contamination of water systems by cross connections.
8. Complete statements concerning two methods of testing a water system for leaks.
9. Make an isometric drawing of a hot and cold water system for a two-story house. (Assignment Sheet 1)
10. Determine pipe sizes for a hot and cold water system for a two-story house. (Assignment Sheet 2)
11. Rough-in water supply lines for bathtubs. (Job Sheet 1)
12. Rough-in water supply lines for a water closet. (Job Sheet 2)
13. Rough-in water supply lines for a water heater. (Job Sheet 3)
14. Make water pressure tests on water supply systems. (Job Sheet 4)

Water Systems
Unit 2-D

Information Sheet

1. **Terms and definitions**

    a. **Cross connection**—Any link between contaminated water and potable water in the water system

    b. **Friction loss**—Flow pressure loss caused by liquid coming in contact with the inside of the pipe

    c. **Frost line**—The depth of frost penetration in the soil

    Note: Water pipes should be installed below this depth. In northern climates, the service pipe is buried as much as seven feet or more in the ground.

    d. **Potable water**—Water which is satisfactory for drinking and domestic purposes

    e. **Pressure head**—Amount of force or pressure created by the depth of one foot of water

    f. **Shut-off valve**—A full opening valve installed in the water line wherever a cut-off is required

    g. **Sill cock**—A faucet on the outside of the building to which a garden hose can be attached

2. **Components of a water system in a single-family dwelling and their functions**

    a. **Water main**—A large pipe, buried in the street, which distributes water throughout the town or city

    b. **Service pipe**—Water pipe which supplies water from the water main or other source of supply to the building served

    c. **Water meter**—Records amount of water consumed by residence or dwelling

    Note: In northern climates, the meter is installed in the basement or utility room.

    d. **Curb stop**—A valve placed in the service line at or near the curb, which permits easy control over the system

    e. **Curb box**—A cylindrical casting placed over the curb stop to allow remote opening and closing of the stop

    f. **Distribution pipes**—Pipes which carry water from the service pipe to fixtures in the building

    g. **Meter stop**—A valve installed between the street and the water meter

    h. **Riser pipes**—Pipes which rise vertically from a horizontal pipe

    i. **Shut-off valve**—A valve installed in the water line wherever a cut-off is required

Information Sheet

j. **Air chamber**—A closed section of pipe or coil, or a patented device designed to absorb shock caused by a rapidly closing valve or faucet; this prevents water-hammer and is installed at time of roughing in

k. **Corporation stop**—A valve installed in the service pipe at the water main

3. Factors to consider when installing a hot water system

Note: Refer to local codes.

a. Water heater is located according to:

- Source of cold water supply
- Source of fuel supply
- Access to fuel exhaust if necessary

b. Main hot water pipe should be equal in size to the main cold water pipe.

c. Inlet pipe to the water heater must be at least as large as the outlet pipe.

d. Hot water distribution pipes are equal in sizing and design to the cold water distribution pipe.

4. Sizing of pipes in residential water systems

a. Most town or city water supplies are disbursed from elevated tanks which distribute the water by gravity.

b. Water pressure increases as the height of the water increases.

c. A 1 foot column of water will create .433 pounds per square inch of pressure at the base of the column.

Note: Width of the column has no effect on the pressure.

d. Distribution pipes vary in size according to their fixture application.

e. Rules of thumb for distribution pipe sizes are:

- Up to 3/8″ branches can be supplied by a 1/2″ pipe.
- Up to 1/2″ branches can be supplied by a 3/4″ pipe.
- Up to 3/4″ branches can be supplied by a 1″ pipe.

f. Water flow pressure is reduced by friction loss caused by the water coming in contact with the inside of the pipe.

Note: In long runs of pipe, consult charts for possible excessive friction loss.

g. Number and type of fittings affect water pressure.

Note: Economical use of fittings will reduce cost and help reduce pressure loss.

Information Sheet

5. Materials used in water pipe systems

a. Pipes

- Copper
- Plastic
- Galvanized iron

b. Valves

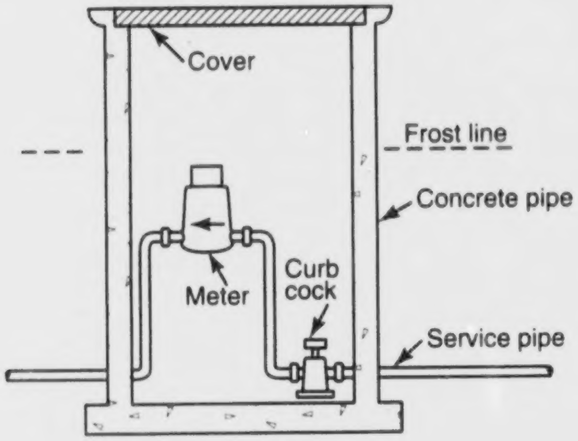
- Brass
- Plastic
- Galvanized iron

Note: Brass far outlasts any other type of valve and therefore is more popular.

6. Prevention of frozen pipes in cold weather

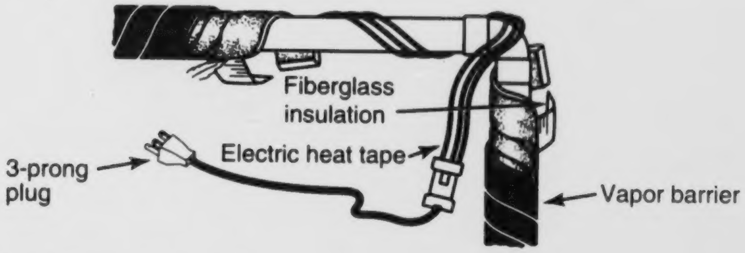
a. Outside building pipe lines must be buried below frost line.

Note: Determine local conditions.



b. Insulate pipes in crawl spaces.

Note: Grade pipes for drainage.

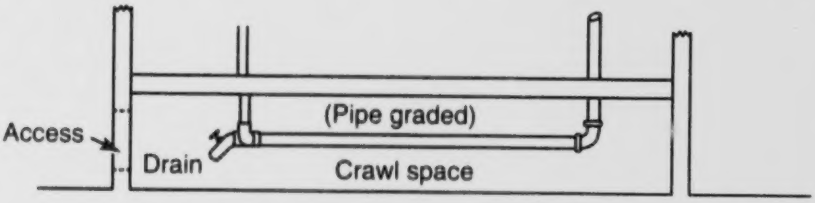


Courtesy of Wrap-on Co., Inc.

c. Avoid installing pipes in outside walls.

d. Install freeze-proof type hose bibs.

e. If pipe is installed in an area subject to freezing, a drain valve must be installed.

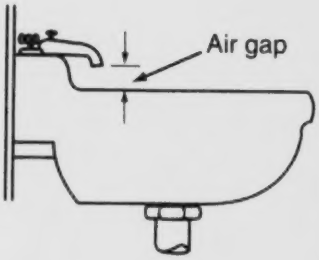


f. If in doubt, insulate or relocate pipes.

Note: An opposite situation can cause warm water in pipes if the pipes are too close to the surface and are affected by the heat of the sun.

7. Methods of preventing contamination of water systems by cross connections

a. Install properly designed fixtures and fittings that allow for sufficient air gap between water supply inlet and fixture rim.

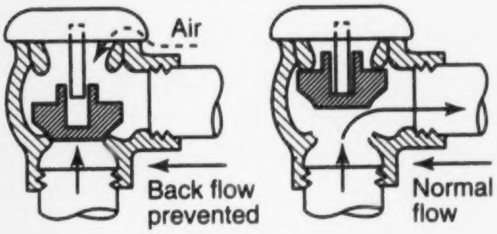


Fixture	Minimum Air Gap
Lavatory	1"
Sink	1 1/2"
Laundry Tub	1 1/2"
Bathtub	2"

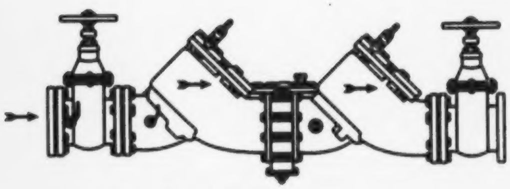
Note: Potable water systems, must not interconnect with other systems.

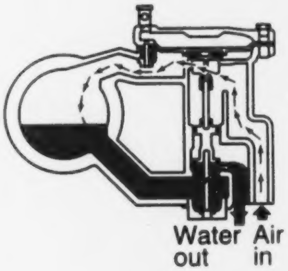
Information Sheet

b. Install vacuum breakers where air gap is limited, to prevent contaminated water from backing up into sanitary water supply.



c. Install a reduced pressure backflow preventer (B.F.P.) at each cross connection to provide protection of the potable water supply.

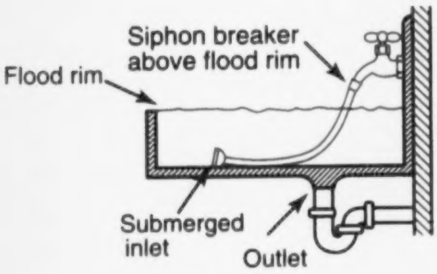




Courtesy of Watts Regulator Co.

Note: This type of relief valve incorporates two channels: one for air and one for water. When the relief valve opens (see diagram), the right-hand channel admits air to the top of th reduced pressure zone, relieving the zone vacuum. The channel on the left then drains the zone to atmosphere.

d. Install a siphon breaker at water inlet supply to prevent siphonage of contaminated water into supply line.



Information Sheet

8. Testing water systems for leaks

a. Water method

- The test pressure should not be less than the pressure of the system to be used.
- Codes usually specify that water for these tests comes from normal source of supply.

  Note: Some codes specify that only water tests are acceptable.
- Testing from the normal source of supply requires that the plumbing installation be connected to the street main or to a neighboring residence.

b. Air method

- Test pressure is usually 50 psi for 4 hours.
- Pressure gauge must be supplied and attached to piping installation by plumber.

Water Systems
Unit 2-D

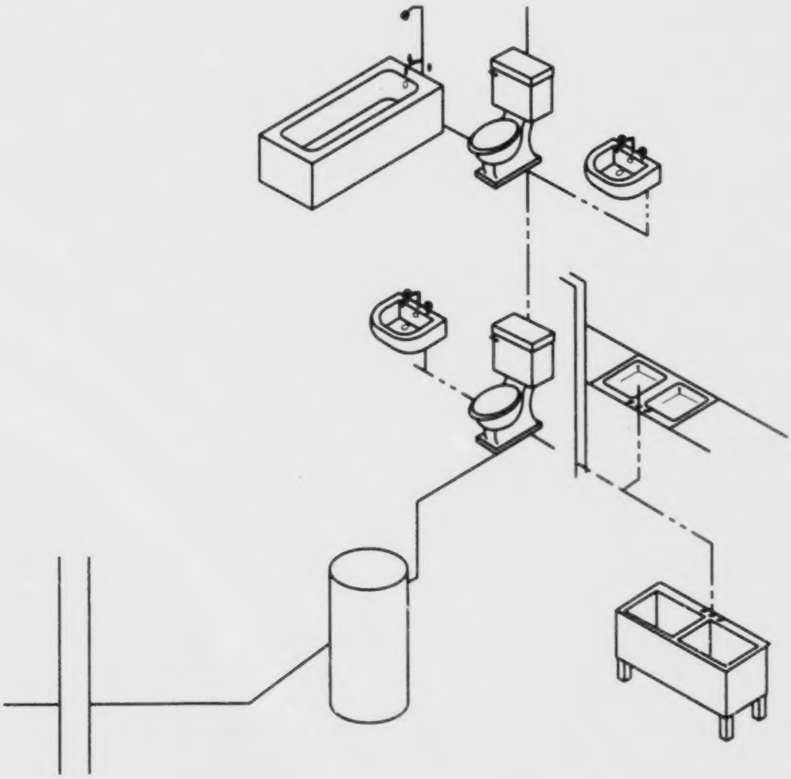
Assignment Sheet 1— Make an Isometric Drawing of a Hot and Cold Water System for a Two-Story House

Name ______________________________ Overall Rating ______________

Evaluation Criteria	**Rating**
• Directions are followed	______
• All answers are correct	______
• Assignment is neat and completed on time	______

Directions: Use the information provided on the isometric fixture layout below to make an isometric drawing of a hot and cold water system for a two-story house. The following components should be included on the drawing:

- Service pipe with valves
- Meter with valves
- Laundry tray connections
- Water heater
- Kitchen sink risers
- Second-floor bathroom risers
- Bath, lavatory, and water closet distribution pipes
- Air chambers for each bathroom fixture



Water Systems
Unit 2-D

Assignment Sheet 2—Determine Pipe Sizes for a Hot and Cold Water System for a Two-Story House

Name ______________________ Overall Rating __________

Evaluation Criteria	Rating
• Directions are followed	______
• All answers are correct	______
• Assignment is neat and completed on time	______

Directions: Determine the pipe sizes needed for the hot and cold water system developed in Assignment Sheet 1. The service pipe is 3/4".

Pipe	Pipe Size
A. Service pipe	3/4"
B. Meter	______________
C. Laundry tray	______________
D. Water heater	______________
E. Kitchen sink risers	______________
F. Second-floor risers	______________
G. Second-floor distribution pipe	______________
H. Air chambers	______________

Water Systems
Unit 2-D

Job Sheet 1—Rough-In Water Supply Lines for Bathtubs

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	Rating
• Located stubbed-out lines within ± 1/2" of the manufacturer's specifications	______
• Joints do not leak	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria. Rough-in 1/2" diameter copper water supply lines for a shower, bath, and tub. The location of stubbed-out lines must be within ± 1/2" of the manufacturer's specifications.

A. Equipment and materials

- Soldering equipment
- Rough-in book
- Tubing
- Fittings and valves
- Bath-shower valve
- Pipe straps and nails
- 6′ rule or steel tape
- Pencil
- Safety glasses

B. Procedure

☐ 1. Cut in and solder tee on main hot and cold water lines.

☐ 2. Connect hot and cold water lines for tub and shower bath to main line tees.

☐ 3. Anchor over-rim filler valve in bath wall at proper height and depth.

☐ 4. Connect hot and cold water lines to shower-filler valve with cold water on right, facing fixture.

☐ 5. Anchor and support tubing as necessary.

☐ 6. Solder and anchor shower arm riser.

☐ 7. Install shower arm.

Job Sheet 1

☐ 8. Cap shower and diverter lines.

☐ 9. Ask your instructor to check your work.

☐ 10. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Water Systems
Unit 2-D

Job Sheet 2—Rough-In Water Supply Lines for a Water Closet

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Located stubbed-out lines within ± 1/2″ of the manufacturer's specifications	______
• Joints do not leak	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria. Rough-in a 1/2″ diameter copper water supply line for a water closet. The stubbed-out lines must be located within ± 1/2″ of the manufacturer's specifications. Joints must not leak.

A. Equipment and materials

- 6′ rule or steel tape
- Pencil
- Rough-in book
- Soldering tools
- Tubing
- Fittings
- Air chamber
- Pipe straps and nails
- Hammer
- Drilling machine
- Drill

B. Procedure

☐ 1. Mark location of water supply line on a wall.

Note: Normally, supply line is roughed-in 6″ left of center of fixture.

☐ 2. Solder tee on main water supply line, if necessary.

☐ 3. Connect fixture supply branch to main supply tee.

☐ 4. Install air chamber on fixture supply line, if required.

☐ 5. Install supply line out of wall at correct height from floor.

Note: Normally, tubing should protrude 6″ out of wall.

Job Sheet 2

☐ 6. Anchor and support supply line with pipe straps.

☐ 7. Cap end of fixture supply line.

☐ 8. Ask your instructor to check your work.

☐ 9. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Water Systems
Unit 2-D

Job Sheet 3—Rough-In Water Supply Lines for a Water Heater

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Located stubbed-out lines within ± 1/2" of the manufacturer's specifications	______
• Joints do not leak	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria. Rough-in a 1/2" diameter copper water supply line for a water heater. The stubbed-out lines must be located within ± 1/2" of the manufacturer's specifications. Joints must not leak.

A. Equipment and materials

- 6′ rule or steel tape
- Soldering equipment
- Tubing
- Fittings and valves
- Pipe straps and nails
- Hammer

B. Procedure

☐ 1. Mark location of water supply line on a wall.

☐ 2. Cut in and solder tee on main water supply line, if necessary.

☐ 3. Connect fixture supply branch to main supply tee.

☐ 4. Install supply line out of wall at correct height.

Note: Normally, tubing must protrude 6" out of wall.

☐ 5. Anchor and support supply line as necessary.

☐ 6. Cap end of fixture supply line.

☐ 7. Ask your instructor to check your work.

Job Sheet 3

☐ 8. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ____________________

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Water Systems
Unit 2-D

Job Sheet 4—Make Water Pressure Tests on Water Supply Systems

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Followed correct procedures for water pressure test	______
• Accurately evaluated water supply lines	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Testing apparatus
- Pipe caps and plugs
- Pipe wrenches
- Pipe compound or tape

B. Procedure

☐ 1. Cap or plug all open water supply points in building.

☐ 2. Assemble testing apparatus.

☐ 3. Connect testing apparatus at temporary water service valve.

☐ 4. Remove cap or plug from uppermost supply point; bleed air and recap.

☐ 5. Purge air from system, using bleed method.

☐ 6. Apply desired pressure to system, using pump.

☐ 7. Close gate valve nearest pump; observe gauge for pressure drop.

  - If drop occurs, check system for leaks.
  - If no drop in pressure occurs, note pressure reading and close second gate valve.

☐ 8. Recheck in one hour by opening second gate valve and observing for pressure drop.

☐ 9. Close both gate valves.

Job Sheet 4

☐ 9. Close both gate valves.

☐ 10. Remove pump and allow system to remain pressurized 24 hours and then recheck.

☐ 11. Ask your instructor to check your work.

☐ 12. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ____________________

Joining Pipes
Unit 3-D

Objective Sheet

Unit Objective

After completing this unit, the student should be able to join steel, cast iron, copper, and plastic pipe. The student should demonstrate these competencies by completing the job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to joining pipes with their definitions.
2. Select tools, materials, and equipment necessary to join steel pipe.
3. Select tools, materials, and equipment necessary to join cast iron pipe by the compression and no-hub methods.
4. Select tools, materials, and equipment necessary to join copper tubing by the sweat joint, compression, and flare methods.
5. Select tools, materials, and equipment necessary to join PVC and flexible plastic pipe.
6. Select tools, materials, and equipment necessary to join pipe by using the roll-grooved coupling method.
7. Cut, ream, thread, and join a piece of 1″ galvanized steel pipe to a 1″ fitting. (Job Sheet 1)
8. Join cast iron pipe to a cast iron fitting using a no-hub joint. (Job Sheet 2)
9. Join cast iron pipe to a cast iron fitting using a compression joint. (Job Sheet 3)
10. Cut, ream, and join copper tubing using the sweat method. (Job Sheet 4)
11. Cut, ream, and join copper tubing using a compression joint. (Job Sheet 5)
12. Cut, ream, and join copper tubing using a flare joint. (Job Sheet 6)
13. Cut, ream, and join copper tubing using a hammered flare joint. (Job Sheet 7)
14. Cut, ream, and join PVC pipe to a PVC fitting. (Job Sheet 8)
15. Cut, ream, and join flexible plastic pipe with insert fittings. (Job Sheet 9)
16. Join clay pipe with couplings. (Job Sheet 10)
17. Wipe clay pipe joints. (Job Sheet 11)
18. Cut cast iron soil pipe with snap-type chain cutter. (Job Sheet 12)

Objective Sheet

19. Bend copper tubing with a spring bender. (Job Sheet 13)
20. Thread steel pipe with an adjustable die. (Job Sheet 14)
21. Join cast iron pipe to clay pipe. (Job Sheet 15)
22. Join ductile iron pipe using the roll-grooved coupling method. (Job Sheet 16)

Joining Pipes
Unit 3-D

Information Sheet

1. **Terms and definitions**

    a. **Cementing**—Method of using a solvent to join PVC pipe

    b. **Hub**—Expanded end of cast iron pipe which receives the spigot end of a pipe or fitting

    Note: The "hub" is sometimes referred to as the "bell."

    c. **Insert joining**—Method of joining flexible plastic pipe

    d. **Neoprene gasket**—Insert in cast iron hub which makes up part of a watertight compression joint

    e. **No-hub**—Type of cast iron pipe to be joined by special fittings

    f. **Pipe compound (dope)**—Substance applied to pipe threads to help seal the joint

    g. **Reaming**—Removing burrs from inside edge of pipe

    h. **Spigot end**—End of fitting or pipe which is inserted into hub (or bell)

    i. **Sweating**—Method of joining copper tubing using flux and solder applied with heat

    j. **Teflon tape**—Tape used as a joint sealant in place of pipe compound

    k. **Threading**—Cutting spiral grooves on the end of pipe to facilitate joining with a fitting or another pipe

2. **Tools, materials, and equipment necessary to join steel pipe**

    Note: Refer to Section B, Unit 1, for illustrations and uses of tools, materials, and equipment listed in this objective.

    a. Cutter

    b. Reamer

    c. Pipe vise

    d. Oil can

    e. Adjustable stock-and-die set

    f. Pipe compound (dope) or tape

    g. Pipe wrench

    h. Pipe

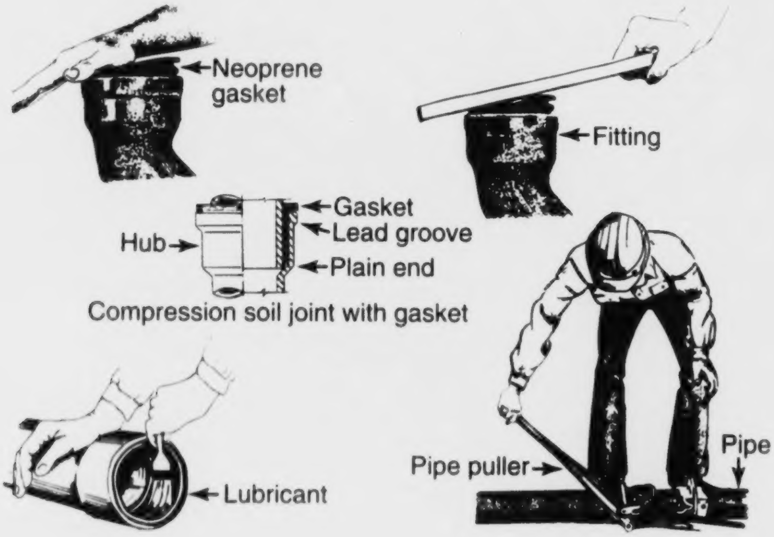
    i. Fitting

Information Sheet

3. Tools, materials, and equipment necessary to join cast iron pipe

Note: Art in this objective is courtesy of Tyler Pipe Company.

a. Compression method



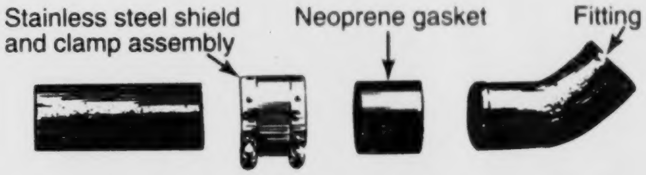
- Neoprene gasket
- Gasket lubricant
- Lead hammer
- Pipe puller
- Pipe
- Fitting

b. No-hub method

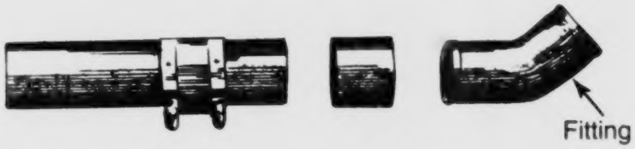
- Neoprene gasket
- Stainless steel shield and clamp assembly
- Approved torque wrench
- Pipe
- Fitting
- Procedure

Information Sheet

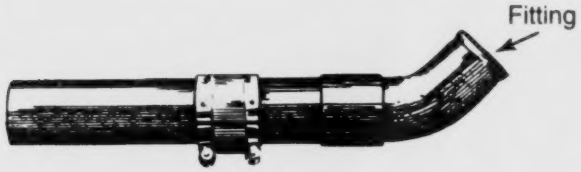
- Detach the neoprene sleeve from the stainless steel clamp assembly.



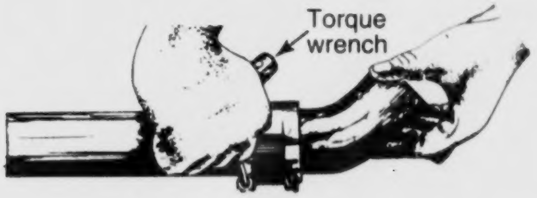
- Slide the stainless steel clamp assembly onto the pipe.



- Insert the spigot ends of the fitting into the neoprene gasket until they butt against the separator ring.



- Tighten clamp using a special torque wrench.



4. **Tools, materials, and equipment necessary to join copper tubing**

Note: Refer to Section B, Unit 1, for illustrations and uses of tools, materials and equipment listed in this objective.

a. Sweat joint method

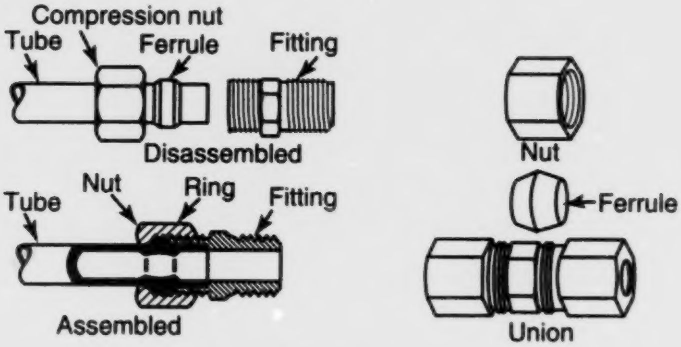
- Tubing cutter
- Reamer
- Sand cloth, emery cloth, steel wool

Information Sheet

- Flux with brush
- Wire solder
- Torch
- Type B gas tank with wrench
- Striker
- Wiping cloth
- Tubing
- Fitting
- Fire extinguisher

b. Compression method

- Tubing cutter and reamer
- Fitting



Compression Fittings

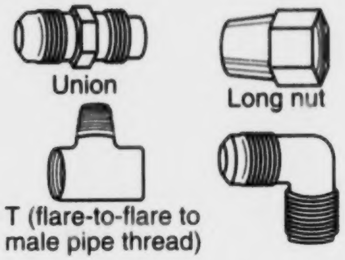
- Open-end wrench or flare-nut wrench
- Adjustable wrench or open-end wrench
- Tubing

c. Flare method

- Tubing cutter and reamer
- Flaring tool and block
- Adjustable wrench, open-end wrench, or flare-nut wrench

Information Sheet

- Tubing
- Fitting



Flared Fittings

- Hammer-type flaring tool
- Swaging tool

5. **Tools, materials, and equipment necessary to join PVC and flexible plastic pipe**

   a. PVC pipe

   - PVC pipe cutter or handsaw
   - Reamer or knife
   - Cleaning solvent with brush
   - Solvent cement with brush
   - Pipe
   - Fitting
   - Wiping cloth

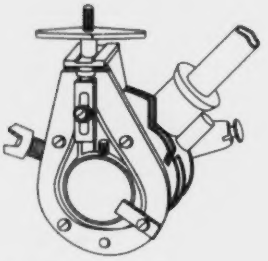
   b. Flexible plastic pipe

   - Pipe cutter or handsaw
   - Reamer or knife
   - Pipe
   - Fitting
   - Clamp
   - Screwdriver
   - Socket wrench

Information Sheet

6. **Tools, materials, and equipment necessary to join pipe using the roll-grooved coupling method**

   a. Roll pipe groover



Victaulic*

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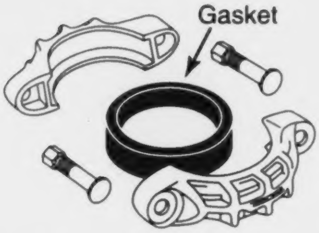
   b. Grooved coupling (or housing)



Victaulic*

   c. Grooved coupling gasket

   d. Non-petroleum based lubricant

   e. Socket wrench

   f. Clean cloth

   g. Pipe

Joining Pipes
Unit 3-D

Job Sheet 1—Cut, Ream, Thread, and Join a Piece of 1″ Galvanized Steel Pipe to a 1″ Fitting

Name ____________________ Attempt Number __________

Date ____________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Joint is tight	_____
• Used correct tools and methods	_____
• Demonstrated proper safety precautions	_____
• Demonstrated correct use of tools and materials	_____
• Demonstrated quality of workmanship	_____
• Completed job neatly and on time	_____

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Die
- Die stock
- Pipe vise
- Flat file
- Oil can (cutting oil)
- Steel pipe
  Note: Ask instructor what type and size of steel pipe to use for this job.
- Pencil
- Shop towel
- Safety glasses
- Pipe cutter
- Reamer

B. Procedure

☐ 1. Put on safety glasses and gather tools and equipment.

☐ 2. Secure pipe in vise.

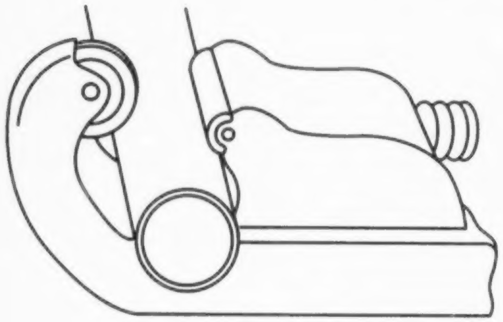
☐ 3. Mark place for cut with pencil.

☐ 4. Open pipe cutter until it will fit over pipe.

Job Sheet 1

☐ 5. Locate cutter wheel on the pencil mark (Figure 1).

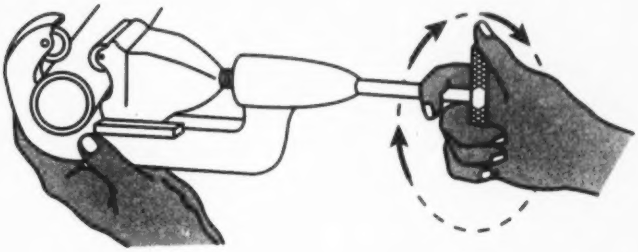
FIGURE 1



☐ 6. Snug cutter up to pipe by rotating screw handle (Figure 2).

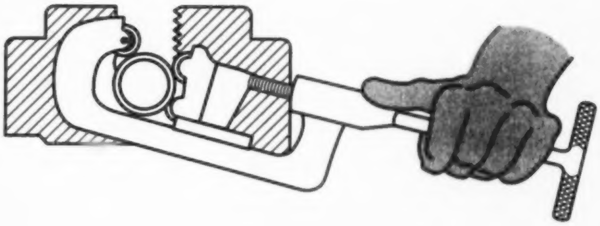
Note: Do not over tighten, as this can break cutter wheel.

FIGURE 2



☐ 7. Rotate cutter counterclockwise to start groove (Figure 3).

FIGURE 3



☐ 8. Tighten cutter 1/4 of a turn for each full revolution around the pipe.

Note: Over tightening can cause cutters to break.

Job Sheet 1

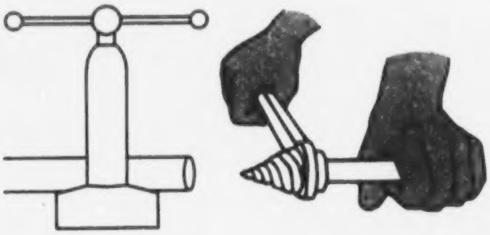
☐ 9. Continue process until pipe is cut.

Caution: When cutting short pieces of pipe, be careful not to cut your arm while rotating the cutter around the pipe.

☐ 10. Clean pipe and cutter with shop towel.

☐ 11. Insert reamer tip in pipe (Figure 4).

FIGURE 4

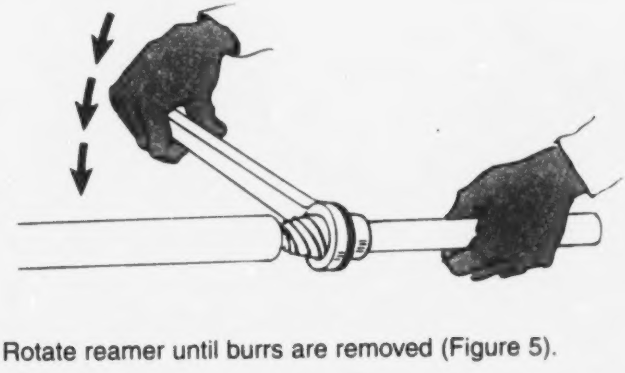


☐ 12. Apply light forward pressure to push reamer into pipe.

☐ 13. Start rotating reamer (Figure 5).

Note: Reamer should bite instantly if proper pressure is applied. Reamer can be damaged if rotated in the wrong direction.

FIGURE 5



☐ 14. Rotate reamer until burrs are removed (Figure 5).

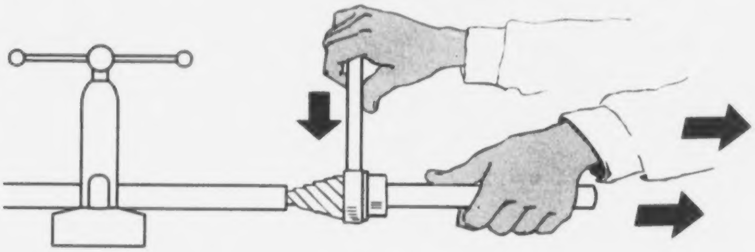
Note: This is a developed skill; the reamer can be pulled out and your progress inspected.

Job Sheet 1

☐ 15. Pull reamer back while continuing to rotate (Figure 6).

Note: This prevents the reamer from leaving a burr.

FIGURE 6



☐ 16. Clean reamer with shop towel.

☐ 17. Lubricate end of pipe with cutting tool.

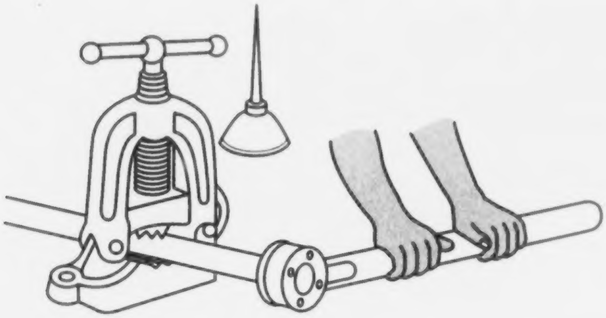
☐ 18. Place die in die stock and secure.

☐ 19. Place die on pipe.

☐ 20. Start die straight on the pipe.

☐ 21. Press die on pipe evenly and turn the die (Figure 7).

FIGURE 7



☐ 22. Apply plenty of cutting oil while turning the die.

Note: Place a container under pipe vise to catch dripping oil.

☐ 23. Continue this procedure until the desired amount of threads has been cut.

☐ 24. Release die by turning ratchet lock 180°.

Job Sheet 1

☐ 25. Remove die by turning counterclockwise.

Note: Hold onto the die stock firmly while removing it so as not to drop it when it comes to the end of the threads.

☐ 26. Clean threads with a brush.

Caution: Do not use compressed air for cleaning.

☐ 27. Ask your instructor to check your work.

☐ 28. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Joining Pipes
Unit 3-D

Job Sheet 2—Join Cast Iron Pipe to a Cast Iron Fitting Using a No-Hub Joint

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	Rating
• Used correct methods and tools	______
• Joints do not leak	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Neoprene gasket
- Stainless steel shield and clamp assembly
- Socket wrench
- Pipe
- Fitting

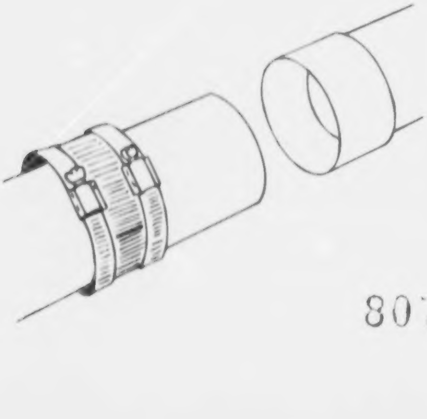
B. Procedure

☐ 1. Place neoprene gasket over one end of pipe.

Note: In this method of joining, no hubs are used.

☐ 2. Place the stainless steel shield and clamp assembly over the end of the other pipe (Figure 1).

FIGURE 1



Job Sheet 2

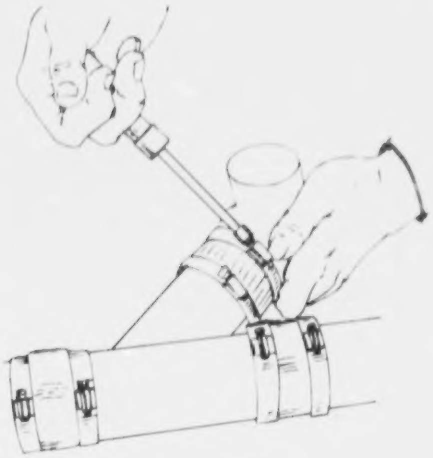
☐ 3. Fit ends of the pipes against the molded shoulder inside the gasket.

Note: Pipe ends must fit snugly.

☐ 4. Slide shield and clamp assembly over gasket and tighten clamps (Figure 2).

Note: A special torque socket wrench is available for tightening clamps.

FIGURE 2



☐ 5. Ask your instructor to check your work.

☐ 6. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Joining Pipes
Unit 3-D

Job Sheet 3—Join Cast Iron Pipe to a Cast Iron Fitting Using a Compression Joint

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• General appearance is satisfactory	______
• Used correct methods and tools	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Neoprene gasket
- Gasket lubricant with brush
- Lead hammer
- Pipe puller
- Fitting
- Pipe
- Wiping cloth
- Safety glasses

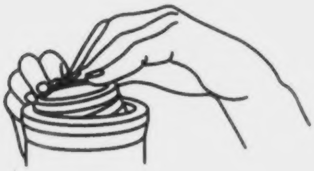
B. Procedure

☐ 1. Clean hub or pipe and spigot end of fitting.

Note: Spigot end of pipe and fittings for compression joining have no bead or ridge.

☐ 2. Insert gasket into hub (Figure 1).

FIGURE 1



☐ 3. Coat gasket and spigot end of fitting with lubricant.

Note: Always use proper lubricant in order to avoid gasket deterioration.

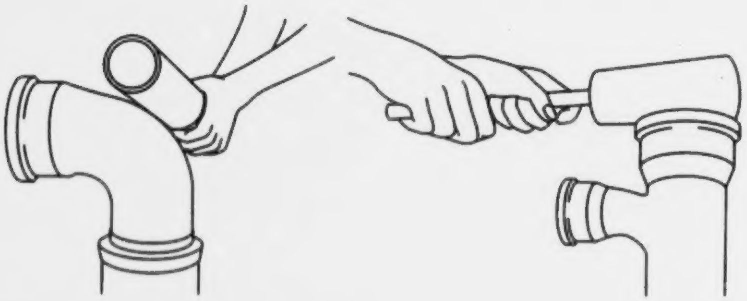
Job Sheet 3

☐ 4. Stand pipe in vertical position and start spigot end of fitting into gasket.

Caution: "Weight" of fitting and pipe must be the same; an "extra heavy" fitting will not fit into a "medium" hub.

☐ 5. With someone holding the pipe and fitting, drive the fitting into the hub with a lead hammer (Figure 2).

FIGURE 2



☐ 6. To join pipe to pipe or pipe to fittings, proceed through steps 1, 2, and 3.

☐ 7. With the pipes lying on the floor or ground, start the spigot end into the gasket.

☐ 8. Clamp one end of the pipe puller to the spigot end.

☐ 9. Drop the yoke end of the pipe puller behind the hub.

☐ 10. Pull the handle of the puller, drawing the spigot into the hub.

Note: This operation may have to be repeated in order to ensure a tight fit.

☐ 11. Ask your instructor to check your work.

☐ 12. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Joining Pipes
Unit 3-D

Job Sheet 4—Cut, Ream, and Join Copper Tubing Using the Sweat Method

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• General appearance is satisfactory	______
• Used correct methods and tools	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Tubing cutter
- Reamer
- Sand cloth, emery cloth, steel wool
- Flux
- Torch
- Gas tank with wrench
- Striker
- Wire solder
- Wiping cloth
- Tubing
- Fitting
- Colored safety glasses

B. Procedure

☐ 1. Put on colored safety glasses.

☐ 2. Cut tubing to desired length.

☐ 3. Ream end of cut tubing.

☐ 4. Clean tubing end with sand cloth.

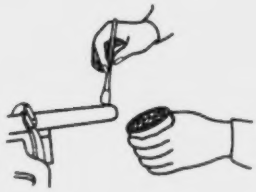
☐ 5. Clean fitting socket with sand cloth.

Job Sheet 4

☐ 6. Apply thin coat of flux to tubing end and fitting socket (Figure 1).

Note: A small brush used to apply the flux helps to keep out dirt.

FIGURE 1



☐ 7. Insert tubing end into fitting socket.

Note: Twist the tubing while inserting in order to spread the flux evenly.

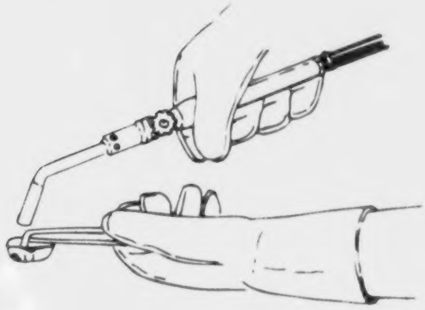
☐ 8. Clean away excess flux with cloth.

☐ 9. Carefully secure tubing and fitting in vise.

☐ 10. Light and adjust torch (Figure 2).

Note: Always use a striker.

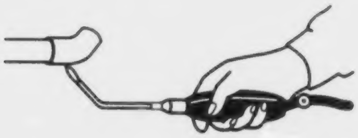
FIGURE 2



☐ 11. Apply heat to fitting (Figure 3).

Note: The inner blue cone of the flame should be about 1/8" away from the fitting.

FIGURE 3



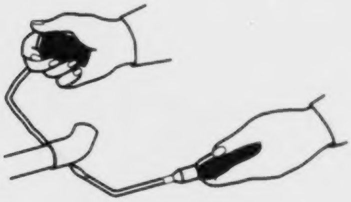
Job Sheet 4

☐ 12. Move the torch flame around the entire joint.

☐ 13. Apply solder (Figure 4).

Note: Amount of solder is determined by size of tubing; for example 1/2" tubing will need approximately 1/2" wire solder, and 3/4" tubing will need 3/4" wire solder.

FIGURE 4



☐ 14. Discontinue heat and solder application when solder flows from joint.

☐ 15. If necessary, wipe excess solder off with cloth.

☐ 16. Turn off torch.

☐ 17. Allow solder to cool.

Note: Do not apply water to cool the fitting.

☐ 18. Ask your instructor to check your work.

☐ 19. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ________________________________

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Joining Pipes
Unit 3-D

Job Sheet 5—Cut, Ream, and Join Copper Tubing Using a Compression Joint

Name ______________________________ Attempt Number ____________

Date ______________________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• General appearance is satisfactory	______
• Used correct methods and tools	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Tubing cutter
- Reamer
- Fitting
- Tubing
- Open-end wrench or flare-nut wrench
- Adjustable wrench

B. Procedure

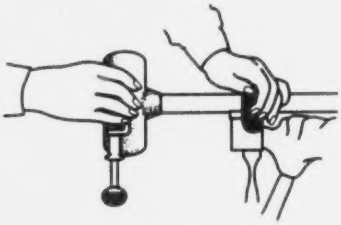
☐ 1. Cut tubing to desired length.

☐ 2. Slip fitting nut and sleeve over end of tubing.

☐ 3. Ream end of tubing (Figure 1).

Note: If tubing is reamed before installing fitting sleeve, the sleeve might not fit over end of tubing.

FIGURE 1



Job Sheet 5

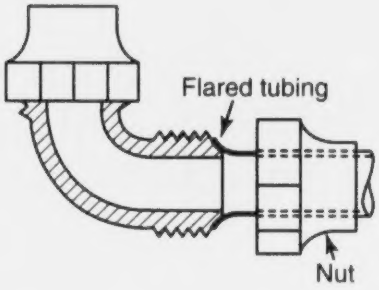
☐ 4. Insert end of tubing into fitting.

Note: Tubing end must fit snugly against bottom of fitting socket.

☐ 5. Slide fitting nut and sleeve up against threaded end of fitting.

☐ 6. Make nut hand-tight on fitting (Figure 2).

FIGURE 2



☐ 7. Hold body of fitting with adjustable wrench.

☐ 8. Turn fitting nut with flare-nut wrench or open-end wrench.

Note: Keep tubing tight against bottom of fitting socket while tightening nut.

☐ 9. Complete tightening of nut on fitting.

☐ 10. Duplicate process on other end of fitting.

☐ 11. Ask your instructor to check your work.

☐ 12. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Joining Pipes
Unit 3-D

Job Sheet 6—Cut, Ream, and Join Copper Tubing Using a Flare Joint

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• General appearance is satisfactory	______
• Used correct methods and tools	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

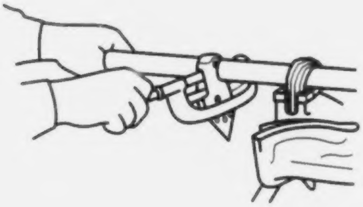
- Tubing cutter
- Reamer
- Flaring tool and block
- Tubing
- Fitting
- Adjustable wrench
- 6′ rule or steel tape
- Open-end or flare-nut wrench

B. Procedure

☐ 1. Measure and cut a desired length of tubing.

- Place cutter on tubing; do not overtighten (Figure 1).

FIGURE 1



- Turn a few revolutions and then tighten a little more.
- Continue to tighten a little at a time while turning the cutter.

Note: Cutter should not be so tight that it bends the end of the tubing.

Job Sheet 6

☐ 2. Slip flare nut over end of tubing.

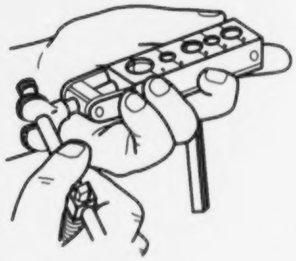
☐ 3. Ream the end of the tubing.

- Do not over ream; just remove the burr.
- Point end of tubing slightly downward while reaming to allow chips to fall out.

☐ 4. Place tubing in flaring block.

☐ 5. Extend end of tubing above the block face about $^1/_3$ the depth of the block chamfer (Figure 2).

FIGURE 2



☐ 6. Secure tubing in flaring block.

☐ 7. Place flaring tool on block.

Note: Flaring tool must be kept oiled and clean.

☐ 8. Tighten cone into tubing a few turns and then back it out.

☐ 9. Continue the tightening and loosening process until the flare is made.

Note: This process tends to make a smooth, polished flare and will lessen the chances of work hardening the tubing.

☐ 10. Do not overtighten the flaring tool.

Note: This will cause the tubing to wash out and possibly cause the flare to split.

☐ 11. Remove flaring tool from block.

☐ 12. Remove tubing from flaring block.

☐ 13. Check fit of flare to seat of flare nut.

☐ 14. Secure flare nut tightly to flare fitting.

Job Sheet 6

☐ 15. Duplicate process on other end of flare fitting.

☐ 16. Ask your instructor to check your work.

☐ 17. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Joining Pipes
Unit 3-D

Job Sheet 7—Cut, Ream, and Join Copper Tubing Using a Hammered Flare Joint

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• General appearance is satisfactory	______
• Used correct methods and tools	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Tubing cutter
- Reamer
- Flaring tool
- Small ball peen hammer
- Fitting
- Tubing
- Adjustable wrench
- 6′ rule or steel tape
- Open-end or flare-nut wrench

B. Procedure

☐ 1. Measure and cut a desired length of tubing.

- Turn a few revolutions and then tighten a little more.
- Continue to tighten a little at a time while turning cutter.

Note: Cutter should not be so tight that it bends the end of the tubing.

☐ 2. Slip flare nut over end of tubing.

☐ 3. Ream the end of the tubing.

- Do not over ream; just remove the burr.
- Point end of tubing slightly downward while reaming to allow chips to fall out.

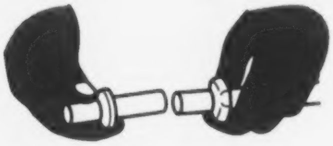
☐ 4. Carefully clean inside of tubing.

Job Sheet 7

☐ 5. Carefully clean flaring tool.

☐ 6. Place end of flaring tool in end of pipe (Figure 1).

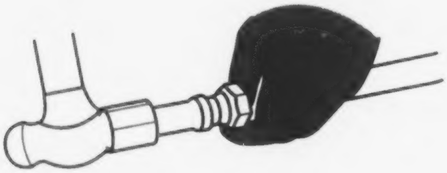
FIGURE 1



☐ 7. Holding tubing and flaring tool in one hand, drive flaring tool into tubing with hammer (Figure 2).

Note: Tubing and flaring tool must be held straight.

FIGURE 2



☐ 8. Drive flaring tool into tubing until desired flare is formed.

Note: This may require checking flare on fitting.

☐ 9. Remove flaring tool from tubing.

Note: This may require turning flare in order to loosen it.

☐ 10. Check fit of flare to seat of flare nut.

☐ 11. Secure flare nut tightly to flare fitting.

☐ 12. Duplicate process on other end of flare fitting.

☐ 13. Ask your instructor to check your work.

☐ 14. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ____________________

Joining Pipes
Unit 3-D

Job Sheet 8—Cut, Ream, and Join PVC Pipe to a PVC Fitting

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Cut pipe accurately	______
• Used correct methods and tools	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

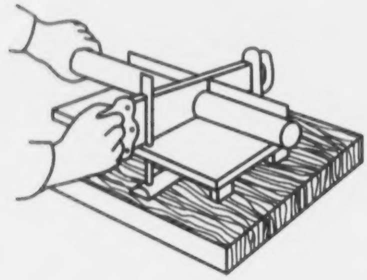
- Pipe cutter or handsaw with miter box
- Reamer
- Cleaning solvent with brush or abrasive paper
- Solvent cement with brush
- Pipe
- Fitting
- 6′ rule or steel tape
- Wiping cloth

B. Procedure

☐ 1. Measure and cut pipe to desired length.

Note: A miter box and miter saw ensure a square cut (Figure 1).

FIGURE 1



Job Sheet 8

☐ 2. Ream pipe.

Caution: Since most PVC reaming is done with a pocket knife or other type of knife, care must be used in this operation.

☐ 3. Apply solvent cleaner to pipe end of fitting socket.

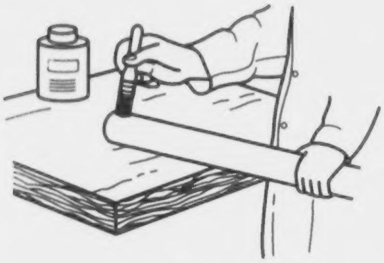
Note: Abrasive paper such as sand cloth or emery cloth may be used.

☐ 4. Wipe solvent cleaner from the pipe end and fitting socket.

Note: This cleans the pipe and removes the gloss for better bonding.

☐ 5. Apply a light, even coat of solvent cement to the pipe end and fitting socket (Figure 2).

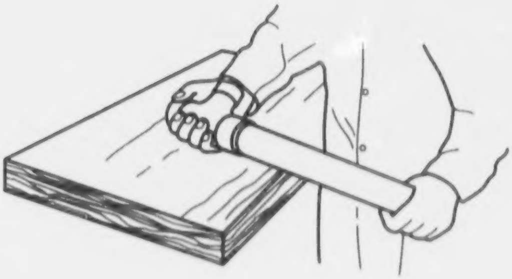
FIGURE 2



☐ 6. Insert pipe all the way into the fitting socket while giving it a quarter turn (Figure 3).

Note: This operation must be done quickly, as the cement sets up in a few seconds.

FIGURE 3



☐ 7. Allow 24 hours before testing PVC joints.

☐ 8. Ask your instructor to check your work.

Job Sheet 8

☐ 9. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Joining Pipes
Unit 3-D

Job Sheet 9—Cut, Ream, and Join Flexible Plastic Pipe With Insert Fittings

Name ______________________________ Attempt Number ______________

Date ______________________________ Overall Rating ______________

Evaluation Criteria	**Rating**
• General appearance is satisfactory	________
• Used correct methods and tools	________
• Demonstrated proper safety precautions	________
• Demonstrated correct use of tools and materials	________
• Demonstrated quality of workmanship	________
• Completed job neatly and on time	________

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Pipe cutter, saw, or knife
- Reamer
- Pipe
- Fitting
- Clamps
- Screwdrivers
- 6′ rule or steel tape
- Socket wrench

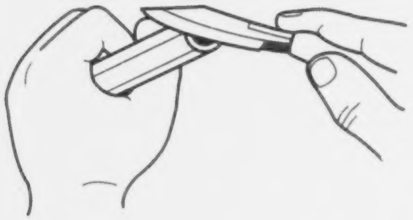
B. Procedure

☐ 1. Measure and cut pipe to desired length.

☐ 2. Ream pipe (Figure 1)

Caution: Since most flexible plastic pipe is cut and reamed with a knife, care must be used in this operation.

FIGURE 1



Job Sheet 9

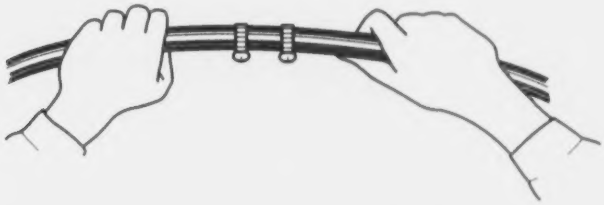
☐ 3. Slip clamp over end of pipe.

Note: Open clamp enough for it to fit loosely on the pipe.

☐ 4. Holding pipe in one hand and the fitting in the other, force fitting into end of pipe (Figure 2).

Note: Cold (rigid) or heavy gauge pipe may need to be softened by hot water or a small flame from a torch.

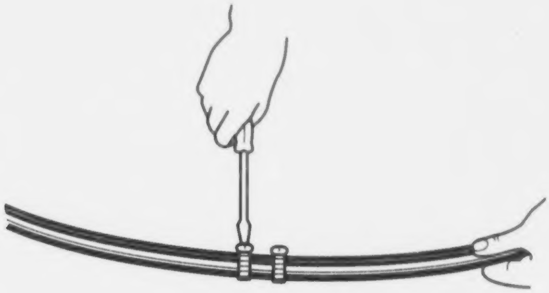
FIGURE 2



☐ 5. Slip clamp over inserted fitting and tighten with screwdriver (Figure 3).

Note: Some clamps are fitted with hex nuts to accommodate socket wrenches.

FIGURE 3



☐ 6. Complete same process on other end of fitting.

☐ 7. Ask your instructor to check your work.

☐ 8. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ____________________

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Joining Pipes
Unit 3-D

Job Sheet 10—Join Clay Pipe With Couplings

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Bonded joint firmly with no evident leaks	______
• Used correct methods and tools	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Two 5′ lengths of 6″ diameter hubless clay pipe
- Joint lubricant
- Brush
- Wiping cloth
- Coupling

B. Procedure

☐ 1. Clean pipe ends with rag.

☐ 2. Apply joint lubricant inside pipe coupling and outside bald end of pipe to be joined.

☐ 3. Place pipe coupling against bald end of pipe to be joined and press two ends together.

☐ 4. Ask your instructor to check your work.

☐ 5. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________________

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Joining Pipes
Unit 3-D

Job Sheet 11—Wipe Clay Pipe Joints

Name ____________________ Attempt Number __________

Date ____________________ Overall Rating __________

Evaluation Criteria	Rating
• Clearance between spigot and bell is equal	______
• Beveled tar compound smoothly along joint	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Yarning iron
- Oakum
- Putty knife
- Tar compound
- 2 lengths of clay pipe

B. Procedure

☐ 1. Position pipes on flat surface.

☐ 2. Slide spigot end into pipe bell.

☐ 3. Stuff oakum between spigot and bell with yarning iron, maintaining equal clearance between exterior of the spigot and the interior of the bell.

Note: Leave 3/4″ to 1″ depth cavity in joint for tar compound application.

☐ 4. Fill joint cavity with tar compound, rolling approximately 1″ extra material.

☐ 5. Bevel and smooth joint with hand or putty knife.

☐ 6. Ask your instructor to check your work.

Job Sheet 11

☐ 7. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ____________________

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Joining Pipes
Unit 3-D

Job Sheet 12—Cut Cast Iron Soil Pipe With Snap-Type Chain Cutter

Name ____________________ Attempt Number ____________

Date ____________________ Overall Rating ____________

Evaluation Criteria	Rating
• Length of tolerance is 1/4″	______
• Pipe ends are free of flakes	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- 6′ rule or steel tape
- Snap-type chain cutter
- Marking soap
- Ball peen hammer

B. Procedure

☐ 1. Measure and mark lengths to be cut.

☐ 2. Stretch chain on cutter and wrap it securely around pipe at point marked previously.

☐ 3. Lock chain cutter in place.

☐ 4. Briskly depress cutter handles until pipe falls apart.

☐ 5. Chip flakes from cut ends with a hammer.

Note: This is necessary when using gasket joints.

☐ 6. Ask your instructor to check your work.

☐ 7. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ____________________

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Joining Pipes
Unit 3-D

Job Sheet 13—Bend Copper Tubing With a Spring Bender

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Length of tolerance is 1/4″	______
• Pipe ends are free of flakes	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Approximately two feet of 1/2″ diameter copper tubing
- 1/2″ spring bender

B. Procedure

☐ 1. Slide tubing bender over tubing to proper location for bend.

☐ 2. Firmly grip one end of the bending spring with one hand and pull the opposite end toward your body at the approximate angle desired.

Note: Both thumbs must nearly touch each other.

☐ 3. Check angle of accuracy to the specific required angle.

☐ 4. Repeat step 2 if adjustments are needed.

Note: The bending spring is not a precision tool; experience and judgment are needed to acquire accuracy.

☐ 5. Ask your instructor to check your work.

Job Sheet 13

☐ 6. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ____________________

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Joining Pipes
Unit 3-D

Job Sheet 14—Thread Steel Pipe With an Adjustable Die

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Threads are free of nicks and burrs	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Adjustable stock and die
- Cutting oil and oil can
- Drip pan
- Pipe vise
- 1″ diameter pipe, 3′ long

B. Procedure

☐ 1. Secure pipe in vise.

☐ 2. Place round guide end of pipe die stock on pipe end to be threaded.

☐ 3. Press dies against pipe end with heel of hand.

Note: Hold hand against dies while taking short, clockwise strokes to begin threading operation.

☐ 4. Continue cutting threads until appropriate number of threads project from outside edges of dies.

Note: Keep die stock oiled during threading process.

☐ 5. Reverse threader and remove dies from threaded end of pipe.

☐ 6. Ask your instructor to check your work.

Job Sheet 14

☐ 7. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ____________________

Joining Pipes
Unit 3-D

Job Sheet 15—Join Cast Iron Pipe to Clay Pipe

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• General appearance is satisfactory	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Short length of cast iron pipe
- Short length of clay pipe
  Note: The clay pipe should be the same size as the cast iron pipe.
- Yarning iron
- Packing iron
- Small trowel
- Clean bucket
- Sand and cement
- Clean cloth
- Safety glasses

B. Procedure

☐ 1. Insert spigot end of cast iron pipe into hub end of clay pipe.

Note: Wipe hub and spigot clean and dry to ensure tight bond of cement.

☐ 2. Yarn and pack oakum into joint.

☐ 3. Mix sand and cement with water (3 parts sand, 1 part cement).

☐ 4. Pack cement into joint and smooth with trowel.

☐ 5. Wipe off excess cement from joint.

☐ 6. Ask your instructor to check your work.

Job Sheet 15

☐ 7. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

____

____

Joining Pipes
Unit 3-D

Job Sheet 16—Join Ductile Iron Pipe Using the Roll-Grooved Coupling Method

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• General appearance is satisfactory	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Safety glasses
- Two 3′ lengths of roll-grooved ductile iron pipe
- Roll pipe groover
- Grooved coupling
- Grooved coupling gasket
- Non-petroleum based lubricant
- Socket wrench
- Clean cloth

B. Procedure

☐ 1. Put on safety glasses.

☐ 2. Using appropriate roll pipe groover, groove ends of pipe to be joined according to coupling manufacturer's specifications.

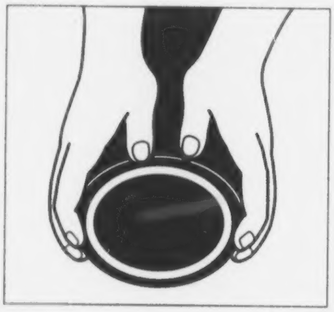
☐ 3. Check gasket to be sure it is suited for intended service, then lubricate according to gasket maker's and lubricant manufacturer's instructions.

Note: Exercise caution to prevent pick-up of foreign materials after lubrication.

Job Sheet 16

☐ 4. Place gasket over pipe end, being sure gasket lip does not overhang pipe end (Figure 1).

FIGURE 1



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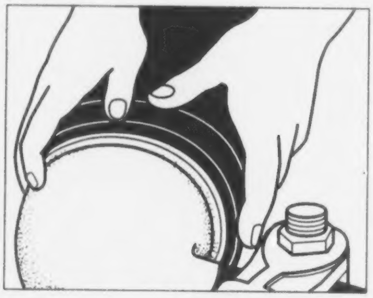
☐ 5. Align pipes, bringing two ends together, and slide gasket between grooves on each pipe (Figure 2).

Note: Make sure that no part of the gasket extends into the pipe grooves.

FIGURE 2



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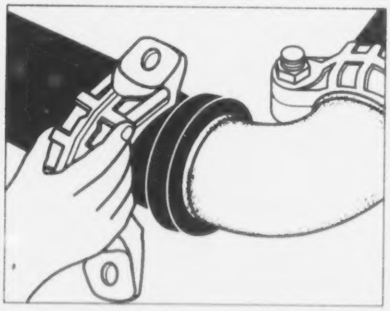
☐ 6. Apply coupling over gasket, making sure the housing engages over the grooves (Figure 3).

FIGURE 3



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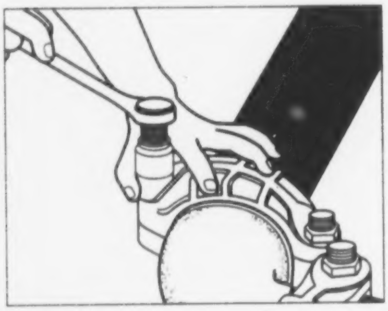
Job Sheet 16

☐ 7. Insert bolts and apply nuts, finger tight.

☐ 8. Tighten nuts alternately and equally with socket wrench until housing bolt pads are firmly together, metal to metal (Figure 4).

Caution: Uneven tightening may cause gasket to pinch.

FIGURE 4



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☐ 9. Ask your instructor to check your work.

☐ 10. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

____

____

Pipe Fittings
Unit 4-D

Objective Sheet

Unit Objective

After completing this unit, the student should be able to identify pipe fittings used in residential plumbing and read fitting sizes. The student should demonstrate these competencies by completing the assignment sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to pipe fittings with their definitions.
2. Match the materials used to make pipe fittings with their specific uses, types, and properties.
3. Identify basic plumbing branches.
4. Identify basic plumbing bends.
5. Identify basic unions and couplings.
6. Identify basic caps and plugs.
7. Identify basic bushings and nipples.
8. Identify basic closet flanges and cleanouts.
9. Identify basic no-hub fittings.
10. Identify flexible plastic (PE) insert fittings.
11. Identify PVC-DWV fittings.
12. Identify polybutylene fittings.
13. Distinguish between the two types of malleable iron fittings.
14. Select four types of adapters.
15. Read fitting sizes. (Assignment Sheet 1)
16. Identify fittings from a sketch of a piping system. (Assignment Sheet 2)

Pipe Fittings
Unit 4-D

Information Sheet

1. **Terms and definitions**

   a. **Adapter**—Type of fitting which joins pipes of different materials

   b. **Bushing**—Fitting used to reduce size

   c. **Drainage fitting**—Fitting designed especially for drainage, allowing the connecting pipe a 2° pitch

   d. **Fitting gain**—That space which the pipe requires in the fitting

   e. **Fittings**—Those parts of the piping system which are used to join pipes and tubes

   Note: Valves are not usually considered fittings.

   f. **FPT**—Female pipe thread

   g. **Joint**—The connection of pipe to fitting or any combination of fittings and pipes

   h. **Malleable**—Not brittle; capable of being shaped

   i. **Malleable iron fittings**—Fittings which have been annealed to reduce brittleness

   j. **MPT**—Male pipe thread

   k. **Oakum**—Loosely woven hemp rope which has been treated with a waterproofing substance and is used to make caulked joints in cast iron pipe systems

   l. **Pipe joint compound**—A substance used on threaded joints to help make them tight, to lubricate them, and to fill in imperfections

   Note: Pipe joint compound is referred to as pipe dope.

   m. **Pressure fitting**—Fitting designed to withstand specified pressure

   n. **Rigid**—Inflexible

   o. **Thread tape**—Substitute for pipe compound

   Note: Thread tape is often Teflon tape.

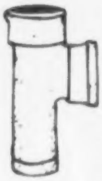
Information Sheet

2. Uses, types, and properties of materials used to make pipe fittings

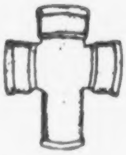
Materials	Uses	Types	Properties
Cast iron	Drains, sewers; vents	Hub and spigot, no-hub	Very brittle, cannot withstand rough treatment; rigid; heavy, needs strong support or base
Copper	Water services and distribution; drainage (above ground);vents; gas (LPG)	Wrought, cast (brass)	Fairly malleable; rigid; lightweight, needs light support
Plastic	Drains; vents; water services; irrigation	PVC (Polyvinyl chloride); PE (Polyethylene); PB (Polybutylene) Note: Check other types of plastic in your locality.	Very malleable; PVC is fairly rigid; PE is fairly flexible; lightweight, needs support
Malleable cast iron	Gas pipe (black); water service and distribution (galvanized)	Black iron; galvanized	Fairly malleable Note: Threads can be damaged easily. Rigid; heavy, needs strong support or base; tends to rust
Brass	Gas lines; water services and distribution	Compression; flare	Fairly malleable Note: Threads can be damaged easily. Rigid; lightweight, needs little support
Vitrified clay	House sewer; city sewer	Hub (bell) and spigot; plain end with coupling	Very brittle, cannot withstand rough treatment; rigid; medium weight Note: Vitrified clay pipe is always installed underground, and it needs a firm, even base.

Information Sheet

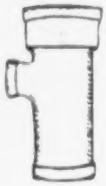
3. Basic plumbing branches



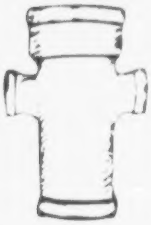
a. Tee



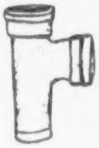
b. Double tee



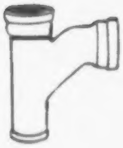
c. Tapped tee



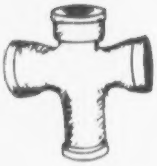
d. Double tapped tee



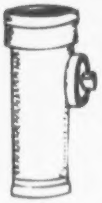
e. Sanitary tee



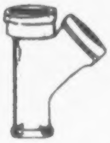
f. Long turn sanitary tee (Combination wye and 1/8 bend)



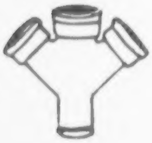
g. Double sanitary tee



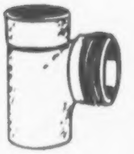
h. Test tee



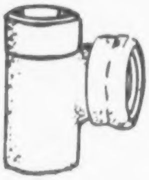
i. Wye



j. Double wye



k. Male adapter (copper)

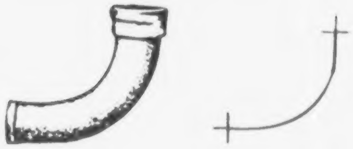


l. Female adapter (copper)

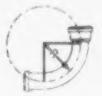
Note: Copper and plastic adapters are threaded for iron pipe size (IPS).

Information Sheet

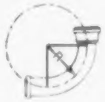
4. Basic plumbing bends



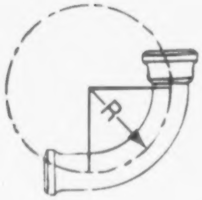
a. Quarter (1/4) = 90°



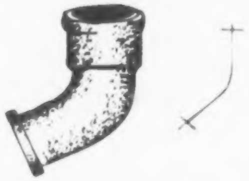
- Short turn



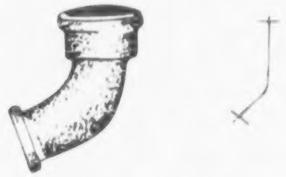
- Medium turn



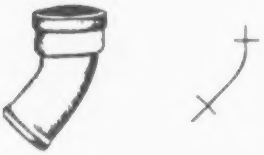
- Long turn



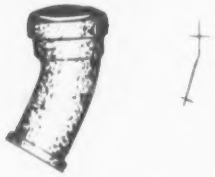
b. Fifth (1/5) = 72°



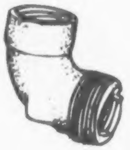
c. Sixth (1/6) = 60°



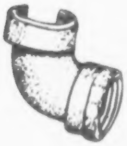
d. Eighth (1/8) = 45°



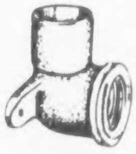
e. Sixteenth (1/16) = 22.5°
(male, copper)



f. Street elbow
(male, copper)



g. Adapter elbow

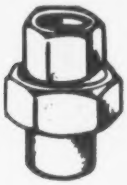


h. Drop-ear elbow (copper to FIP)

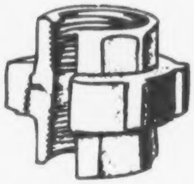
Information Sheet

5. Basic unions and couplings

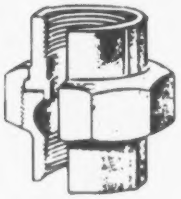
a. Unions



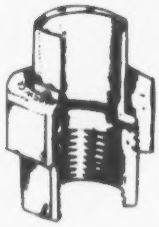
- Straight
  (Copper to copper)



- Ground joint
  (Malleable galvanized iron)

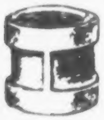


- Gasket type
  (Malleable galvanized iron)

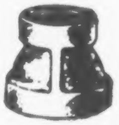


- Dielectric
  (Copper)

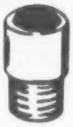
b. Couplings



- Straight



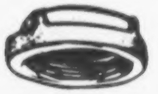
- Reducing



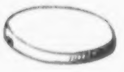
- Male to female adapter

6. Basic caps and plugs

a. Caps

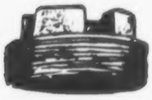


- Cast iron

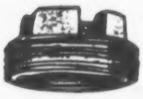


- Test cap (copper)

b. Plugs



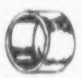
- Solid



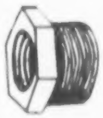
- Cored

7. Basic bushings and nipples

a. Bushings

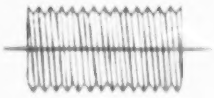


- Copper

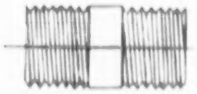


- Malleable cast iron

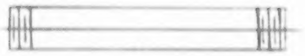
b. Nipples



- Close



- Shoulder

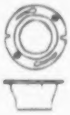


- Long

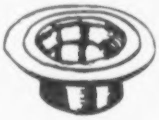
Information Sheet

8. Basic closet flanges and cleanouts

a. Closet flanges

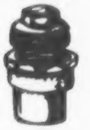


- No-hub slot and notch

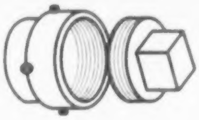


- PVC

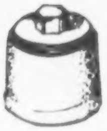
b. Cleanouts



- Copper

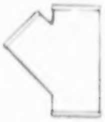


- PVC

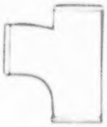


- Cast iron

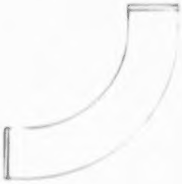
9. Basic no-hub fittings



a. Wye

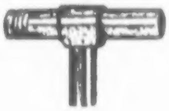


b. Sanitary tee

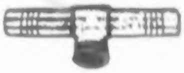


c. Long-turn 1/4 bend

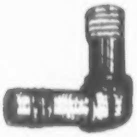
10. Flexible plastic (PE) insert fittings



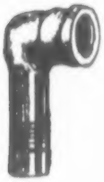
a. Tee



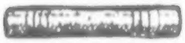
b. Tapped tee



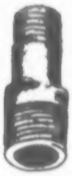
c. 90° elbow



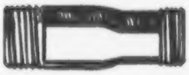
d. 90° female adapter



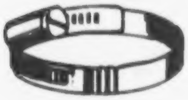
e. Coupling



f. Male adapter elbow

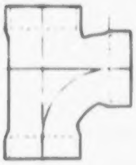


g. Male steel adapter

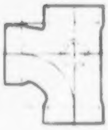


h. Clamp

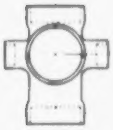
11. PVC-DWV fittings



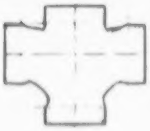
a. Sanitary tee



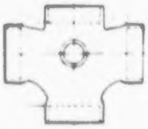
b. Sanitary tee with side inlet (left or right)



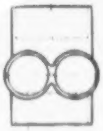
c. Sanitary tee with two side inlets



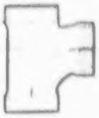
d. Double sanitary tee



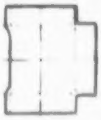
e. Double sanitary tee with side inlet



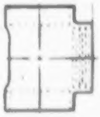
f. Horizontal twin tee (Frog eye tee)



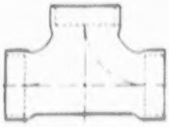
g. Fixture tee



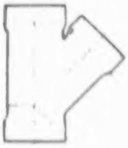
h. Vent tee (Straight tee)



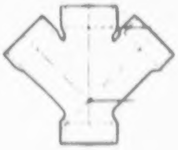
i. Cleanout tee (Test tee)



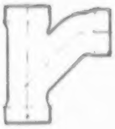
j. Two-way cleanout



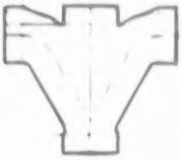
k. Wye



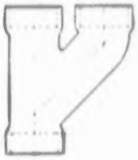
l. Double wye



m. Combination wye and $^1/_8$ bend

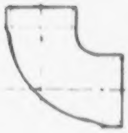


n. Double combination wye and $^1/_8$ bend

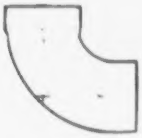


o. Upright wye

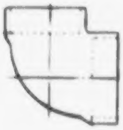
Information Sheet



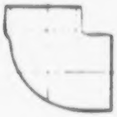
p. ¼ bend



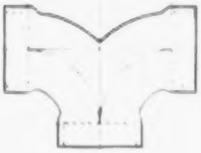
q. ¼ bend, street



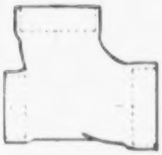
r. ¼ bend, vent



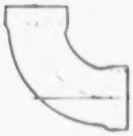
s. ¼ bend, vent-street



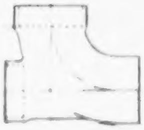
t. Double ¼ bend



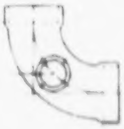
u. ¼ bend with low heel inlet (all hub)



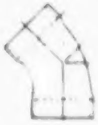
v. Long sweep ¼ bend



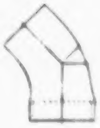
w. Long sweep ¼ bend with low heel inlet



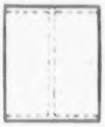
x. Long sweep ¼ bend with side inlet



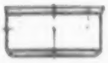
y. ⅛ bend



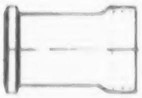
z. ⅛ bend, street



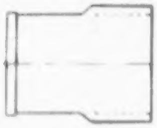
aa. Coupling



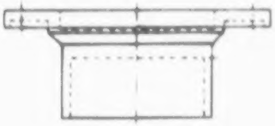
bb. Reducer bushing



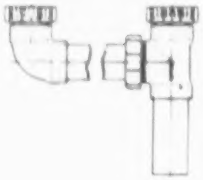
cc. Hub adapter



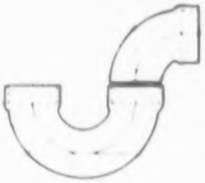
dd. No-hub adapter



ee. Closet flange

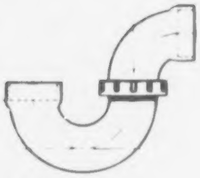


ff. Continuous waste

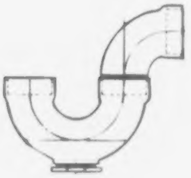


gg. P-trap

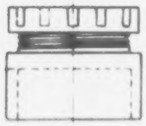
Information Sheet



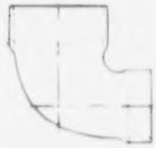
hh. P-trap with union



ii. P-trap with cleanout

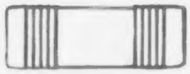


jj. Trap adapter

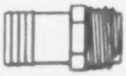


kk. Closet bend

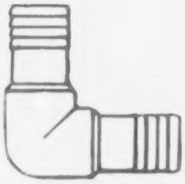
12. Polybutylene fittings



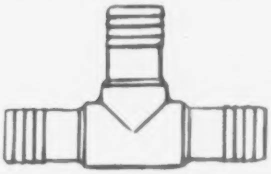
a. Insert coupling



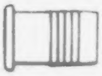
b. Insert male adapter



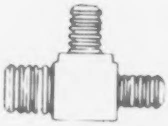
c. Insert elbow



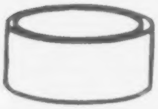
d. Insert tee



e. Insert plug



f. Reducer tee



g. Copper compression rings

Information Sheet

13. **Two types of malleable iron fittings**

    a. Pressure

    - Used for water, gas, and air vent lines
    - Fittings are designed for absolute degree turns

    b. Drainage

    - Used for drainage
    - Fittings are designed for drainage and tapped with a pitch of 1/4" per foot
    - Minimum size manufactured is 1 1/4"
    - The inside of a drainage fitting is smooth and shaped for easy flow.

    Note: Compare pressure and drainage fittings.

14. **Types of adapters**

    a. Copper

    - Copper to cast iron (caulked)
    - Copper to threaded pipe

    b. PVC plastic

    - PVC to cast iron
    - PVC to threaded pipe

Pipe Fittings
Unit 4-D

Assignment Sheet 1—Read Fitting Sizes

Name ______________________________ Overall Rating ______________

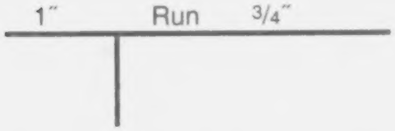
Evaluation Criteria	Rating
• Directions are followed	______
• All answers are correct	______
• Assignment is neat and completed on time	______

Directions: Read the following fittings in this order—size, material, and type. Refer to the example below for practice in reading fittings.

Example

- To read size, the largest size in the run is read first, followed by smaller size, if any, and the branch or "bull" last (Figure 1).

FIGURE 1



= 1" x 3/4" x 1/2"

- To read material, indicate galvanized iron, copper, cast iron, etc.
- To read type, identify as a tee, elbow reducer, etc.

Answer for Figure 1: 1" x 3/4" x 1/2" galvanized iron tee

Problems

1. The main water distribution pipe is 3/4" galvanized pipe. Two 1/2" galvanized iron pipes are to be installed, one for the kitchen sink, the other for the washing machine. Read the fitting appropriate to connect these pipes (Figure 2).

FIGURE 2

ANSWER ______________________________

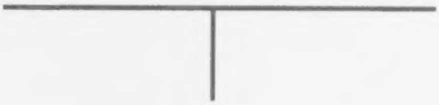
Assignment Sheet 1

2. The same situation as in question 1, but use rigid copper tubing. Read the fitting necessary.

ANSWER ________________________________

3. A 1" galvanized iron water distribution pipe has a 1/2" side outlet for an outside hose bib. Read the fitting (Figure 3).

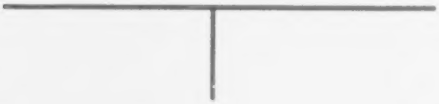
FIGURE 3



ANSWER ________________________________

4. A 3/4" copper water distribution pipe is to supply the second floor and continue on to supply a laundry tray. Read the necessary fitting (Figure 4).

FIGURE 4



ANSWER ________________________________

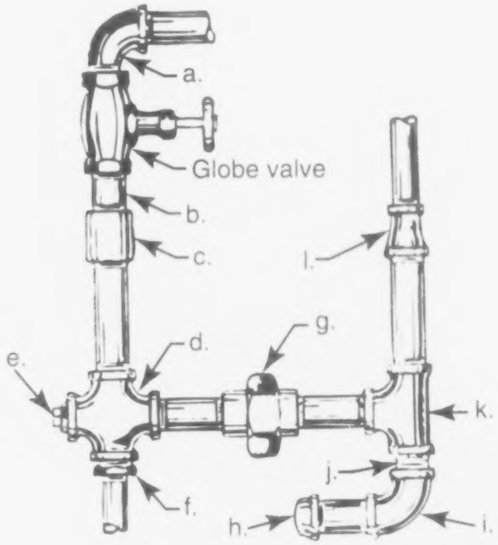
Pipe Fittings
Unit 4-D

Assignment Sheet 2—Identify Fittings From a Sketch of a Piping System

Name ______________________ Overall Rating ____________

Evaluation Criteria	Rating
• Directions are followed	______
• All answers are correct	______
• Assignment is neat and completed on time	______

Directions: Identify the fittings shown in the following sketch of a piping system. Write your answers in the blanks provided.



a. ______________________

b. ______________________

c. ______________________

d. ______________________

e. ______________________

f. ______________________

g. ______________________

h. ______________________

i. ______________________

j. ______________________

k. ______________________

l. ______________________

Pipe
Unit 5-D

Objective Sheet

Unit Objective

After completing this unit, the student should be able to construct a materials take-off list from an isometric drawing. The student should demonstrate these competencies by completing the assignment sheet and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to pipe with their definitions.
2. Select types of pipes used in residential plumbing.
3. Match types of copper pipes with their identification colors.
4. List applications for types of pipe to be used in the plumbing trade.
5. Distinguish between black steel and galvanized steel pipe.
6. List advantages and disadvantages of plastic pipe.
7. Discuss the three common methods of measuring pipe when given illustrations.
8. Construct a materials take-off list from an isometric drawing. (Assignment Sheet 1)

Pipe
Unit 5-D

Information Sheet

1. **Terms and definitions**

   a. **Flexible plastic pipe**—Plastic pipe which comes in a roll and uses slip-in fittings with clamps

   b. **Galvanize**—To coat metal by hot dipping with zinc in order to prevent rusting

   c. **Nipple**—Short piece of pipe, 12" or less in length

   d. **Nominal size**—Name size of pipe rather than actual size

   e. **Plumbing code**—Laws and regulations which stipulate type, size, and quality of pipe material to use

   f. **PVC**—Rigid plastic pipe

   Note: This pipe is generally white. PVC is the abbreviation for polyvinyl chloride.

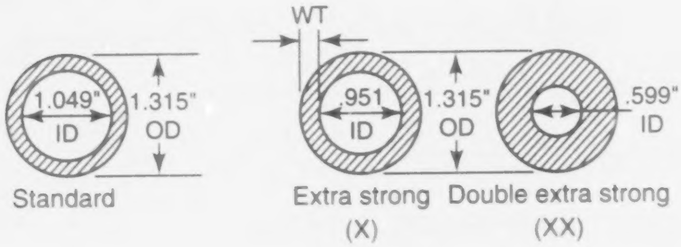
   g. **Tube**—Fluid-carrying pipe which has a thin wall

2. **Types of pipe used in residential plumbing**

   a. Steel

   - Black
   - Galvanized

   Note: Steel pipe comes in three different grades or strengths: standard, extra strong, and double extra strong. Standard weight is adequate for most plumbing installations. The outside diameter (O.D.) of the pipe remains the same regardless of the wall thickness (W.T.).



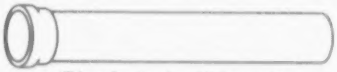
Standard

Extra strong (X)

Double extra strong (XX)

Information Sheet

Steel and Cast Iron Pipe



Single hub, 5' lengths

Diameter	2"	3"	4"	5"	6"	8"	10"	12"	15"
Std.wt.	20	30	40	52	65	100	145	190	255
X wt.	25	45	60	75	95	150	215	270	375

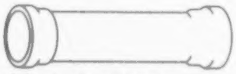
Double hub, 5' lengths

Diameter	2"	3"	4"	5"	6"	8"	10"	12"	15"
Std.wt.	21	31	42	54	68	105	150	200	270
X wt.	26	47	63	78	100	157	225	285	395

No hub

Single hub,10' lengths

Diameter	2"	3"	4"	5"	6"	8"	10"	12"	15"
Std.wt.	38	56	75	98	124	185	270	355	475
X wt.	43	83	108	133	160	265	400	480	705



Double hub, 30" lengths
(25" laying lengths)

Diameter	2"	3"	4"
Std.wt.	11	17	23
X wt.	14	26	33

b. Cast iron

- Hub and spigot
- No-hub

Note: Cast iron pipe is available in one grade, service (SV).

c. Plastic

- PVC (Polyvinyl chloride)
- PE (Polyethylene)

Note: Plastic pipe is available in four different strengths: schedule 40, schedule 80, pressure pipe, and pipe used for no code applications. The selection of pressure pipe is based on the pressure of fluid that is to flow through the pipe. PE pipe is available in high density, which is used for gas piping and water service, and medium density, which is used for irrigation and sewers.

Information Sheet

Types of Plastic Pipe

TYPE	GRADE	DIAMETER RANGE	TYPICAL APPLICATION
ABS	DWV	1 1/4" – 6"	Drainage, waste, and venting in residential construction
	Service	1 1/4" – 6"	Noncode applications
PVC	DWV	1 1/4" – 6"	Drainage, waste, and venting in residential construction
	Thin Wall	1 1/2" – 4"	Drainage, waste, and venting not enclosed within walls (not allowed by some codes)
	Pressure Pipe	1 1/2" – 6"	Selection based on pressure of fluid which is to flow through pipe
CPVC		1/2" – 3/4"	Hot water lines
PE	High Density	1/4" – 12"	Gas piping
	Medium Density	1/4" – 48"	Irrigation, sewer mains
SR		1/2" – 12"	Storm drains, septic tank, and leach fields

d. Copper

- DWV—Rigid
- M—Rigid
- L—Rigid
- L—Soft
- K—Rigid
- K—Soft

Note: Rigid copper pipe is available in 20′ lengths and soft copper pipe is available in 40′, 60′, and 100′ coils.

e. Vitrified clay pipe

Note: Vitrified clay pipe must be dense (concentrated) enough to withstand penetration and deterioration from acids and corrosive wastes. The vitreous (glass like) surface is formed by mixing clay with salt and then firing (baking at high temperature). Usually the fitting and pipe are combined into one piece.

Information Sheet

3. Identification colors of types of copper pipe

a. DWV-Rigid—Yellow

b. M-Rigid—Red

c. L-Rigid—Blue

d. L-Soft—Blue

e. K-Rigid—Green

f. K-Soft—Green

4. Pipe applications in the plumbing trades

Note: Check local codes for pipe applications in your area.

a. Black steel pipe

- Natural gas lines
- Liquefied petroleum gas lines

b. Galvanized steel pipe

Note: Galvanized steel pipe is not to be used on gas lines.

- Drain lines
- Vent lines
- Water lines

c. Plastic

Note: These applications apply to both flexible and PVC pipe.

- Water supply lines
- Underground gas lines
- Drain lines
- Vent lines

d. Copper

- Water lines
- Drain lines
- Vent lines

Information Sheet

- Gas lines

  Note: Gas lines must be made with mechanical joints.

e. Cast iron

- Drain lines
- Vent lines

f. Vitrified clay pipe

- Sewer lines
- Storm drains

5. Differences between black steel and galvanized steel pipe

a. Black steel

- Is varnished black to help prevent rust and distinguish it from galvanized pipe
- Is limited to use with noncorrosive substances such as gas, air, and steam

b. Galvanized steel pipe

- Is hot dipped in zinc to resist rusting
- Is used for applications with corrosive liquids such as water

  Note: Care should be taken with wrenches to avoid removing too much zinc coating.

6. Advantages and disadvantages of plastic pipe

a. Advantages

- Is lightweight
- Resists corrosion and electrolysis
- Is easily installed
- Is comparatively inexpensive

b. Disadvantages

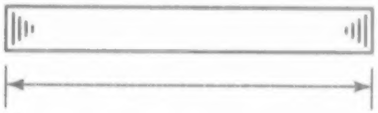
Note: Check manufacturer's specifications.

- Will not withstand temperatures over 150°F
- Is not stable at pressures over 100 psi

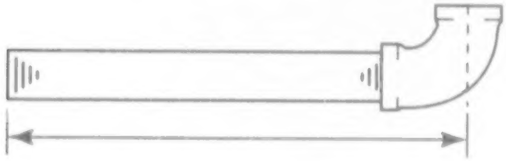
Information Sheet

7. Methods of measuring pipe

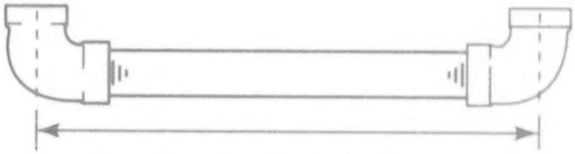
a. End to end—Measure pipe from end to end without fittings



b. End to center—Measure from end of pipe to center of fitting



c. Center to center—Measure from center of one fitting to the center of the other



Pipe
Unit 5-D

Assignment Sheet 1—Construct a Materials Take-Off List From an Isometric Drawing

Name ______________________ Overall Rating ____________

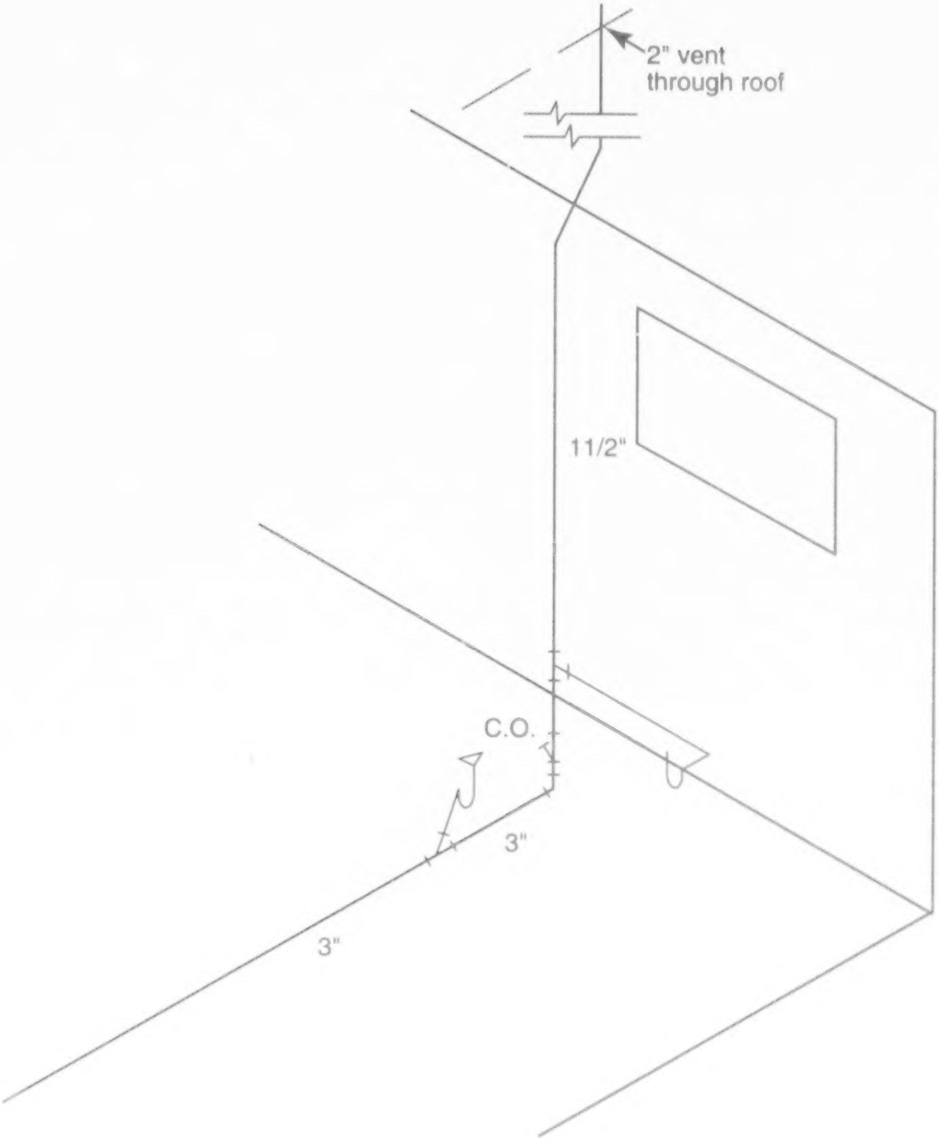
Evaluation Criteria	**Rating**
• Directions are followed	______
• All answers are correct	______
• Assignment is neat and completed on time	______

Directions: Using the piping system shown in Figure 1 on the next page, construct a materials take-off list.

MATERIALS	TOTAL NUMBER
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	
16.	
17.	

Assignment Sheet 1

FIGURE 1



Private Water Systems
Unit 1-E

Objective Sheet

Unit Objective

After completing this unit, the student should be able to compute the cost for plumbing supplies and install a pump and controls according to manufacturer's specifications. The student should demonstrate these competencies by completing the assignment sheet and job sheet and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to private water systems with their definitions.
2. Select true statements concerning types of private water supplies.
3. List possible sources of contamination in private water supplies.
4. Identify types of pumps used for private water systems.
5. Distinguish among the operating principles of pumps used for private water systems.
6. Identify pump controls used on private water systems.
7. Select true statements concerning the applications of various pump controls on private water systems.
8. Compute the cost for plumbing supplies. (Assignment Sheet 1)
9. Install a pump and controls according to manufacturer's specifications. (Job Sheet 1)

Private Water Systems
Unit 1-E

Information Sheet

1. **Terms and definitions**

   a. **Centrifugal**—Operating in a circular motion

   b. **Check valve**—A valve that allows water to flow in only one direction

   c. **Discharge line**—Pipe that carries water from the pump to the pressure tank or water system

   d. **Foot valve**—A device placed at the lower end of the suction pipe in order to keep the pipe full of water

   e. **Gate valve**—A water controller that is used to isolate parts of the pumping system

   f. **Impervious layer**—Subsoil section, usually containing clay or rock, which resists or prevents flow or absorption of water

   g. **Potable water**—Water that is free from impurities which cause disease or harmful effects

      Note: The water shall conform to public health department standards.

   h. **Pressure tank**—A device that receives the discharge from the pump and develops pressure by compressing air

   i. **PSI**—Pounds per square inch; the measurement of pressure in water systems

   j. **Pump**—A device that uses mechanical power to move or lift liquid from one point to another

   k. **Reciprocating**—Operating in a back-and-forth motion

      Note: A reciprocating pump operates much like the pistons in an automobile.

   l. **Relief valve**—A safety device installed in a water system to automatically reduce excess pressure

   m. **Suction line**—Pipe that carries water from its source, such as a well or spring box, to the pump

   n. **Water table**—The height to which underground water will be found in a specific location

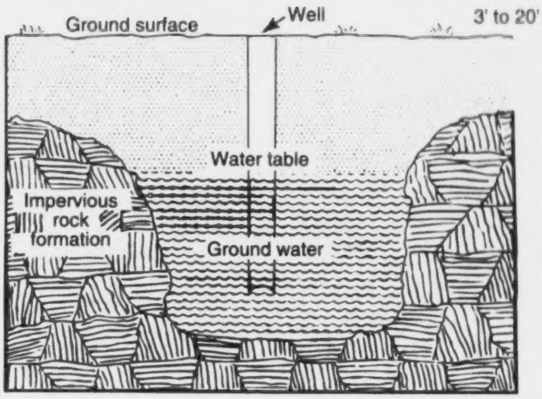
      Note: The water table tends to follow roughly the contour of the land. It will vary according to consumption rate and weather conditions and can be from a few feet to hundreds of feet below ground level.

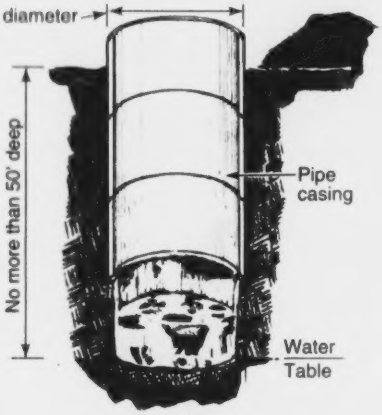
Information Sheet

2. Types of private water supplies and their descriptions

a. Dug well

- A dug well consists of a hole in the ground from 3′ to 20′ in diameter and deep enough to extend below the ground water table.

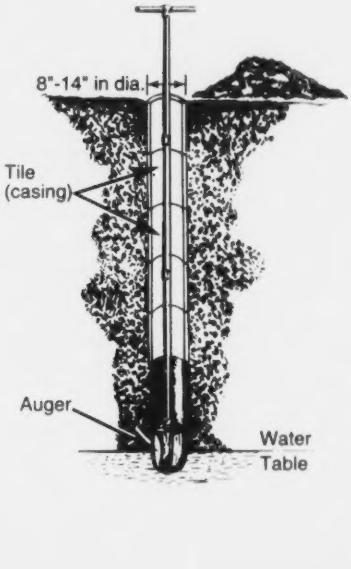




- The dug well is lined with stone, brick, or concrete pipe to prevent cave-in.
- The dug well is seldom more than 50′ deep because of the difficulty of the excavation.

b. Bored well

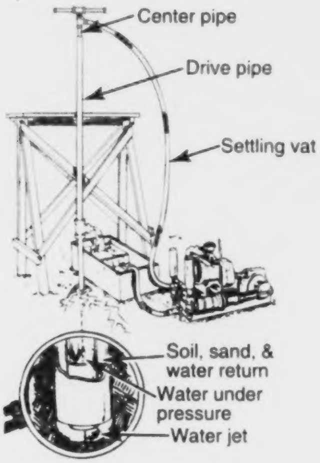
- A bored well is made with an earth auger, either hand or power operated, and is usually from 8″ to 14″ in diameter and deep enough to extend below the water table.
- After the water table has been reached a well casing is inserted to prevent contamination.



Information Sheet

c. Drilled well

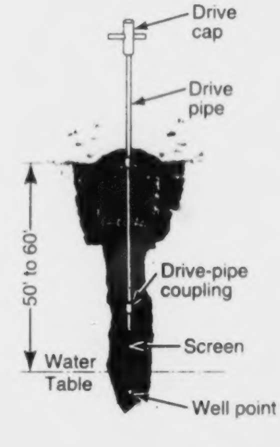
- A drilled well consists of a steel pipe, from 4″ to 6″ in diameter, used as a casing to protect the hole from cave-ins and other disturbances.



- Drilled wells are used when greater water depth is needed.
- In loose soils, the casing is extended all the way to the water-bearing area.
- In impervious soil, the casing is extended through the surface to the impervious layer.
- Drilling can be done by percussion (punching and hammering with a chisel-shaped bit), or by rotary (biting and turning). Rotary drilling uses a water slurry as a cutting fluid and coolant to speed the process.

d. Driven well

- A driven well consists of a pipe with a device on the lower end which is screened to allow ground water to enter the pipe.



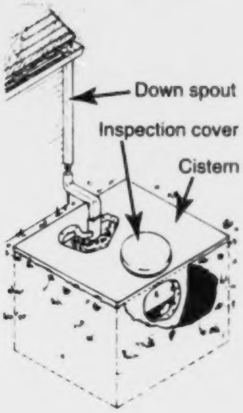
Information Sheet

- Driven wells are used when soil is relatively free of rock and the water table is within 50′ to 60′ of the ground surface.
- Driven wells can become less productive if screens become clogged with sand.
- It is possible to connect two or more driven wells to increase water supply.
- A "washed" or "jetted" driven well saves manpower, but requires a pumping apparatus.

e. A spring is water that rises to the surface from an underground source.

Note: Springs are seldom found where the general lay of the land is flat.

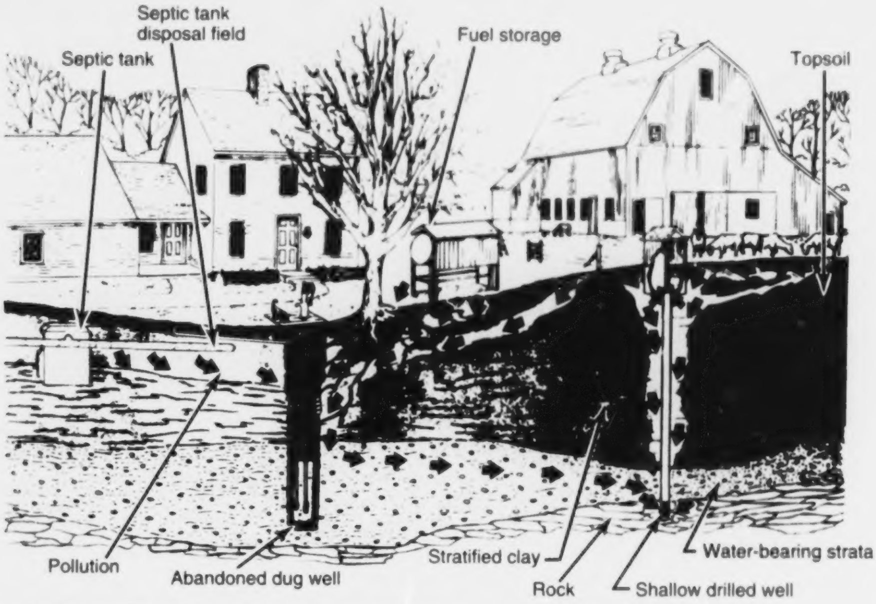
f. Storage tanks provide water collected from rain or subsurface ground water.



g. Ponds or lakes can be a source of potable water if proper treatment is applied.

Information Sheet

3. Sources of contamination in private water supplies



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a. Leaking sewer lines

b. Houses treated for termite control

c. Septic tanks

d. Leach (absorption) fields

e. Barnyards and livestock feedlots

f. Flooded land

g. Unsealed wells

Note: Unsealed wells are susceptible to contamination from debris, animals, and vermin.

h. Leaking underground fuel tanks

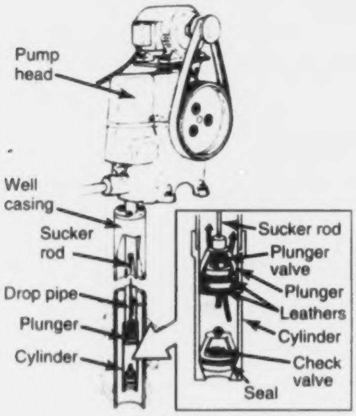
i. Waste disposal sites

Information Sheet

4. Types of pumps

Note: Illustrations for a–c are used with permission of American Association for Vocational Instructional Materials from *Planning for an Individual Water System.*

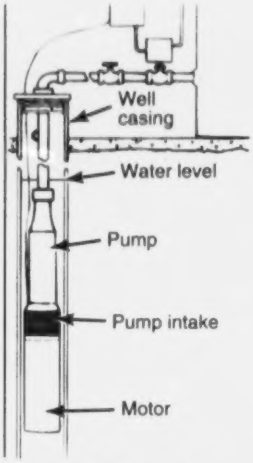
a. Piston (reciprocating)



(Deep Well)
(Pumping mechanism is in the well, usually below water level.)

Note: Piston pumps can be either double acting or single acting, and can be either shallow- or deep-well pumps.

b. Centrifugal pump

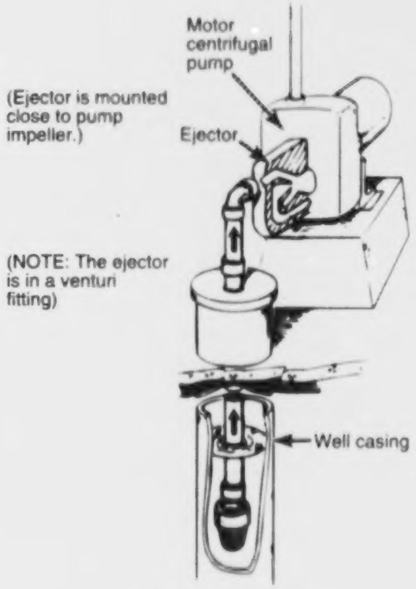


(Deep Well Submersible)

(Pump and motor are installed in the well below the water level.)

Note: Centrifugal pumps can be either shallow- or deep-well pumps.

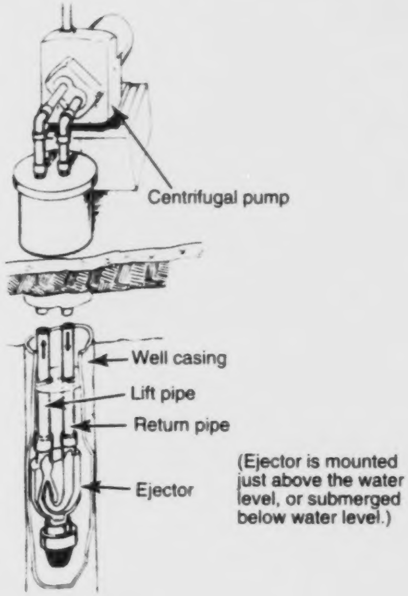
c. Jet pump



(Ejector is mounted close to pump impeller.)

(NOTE: The ejector is in a venturi fitting)

Shallow Well Jet Pump



(Ejector is mounted just above the water level, or submerged below water level.)

Deep Well Jet Pump

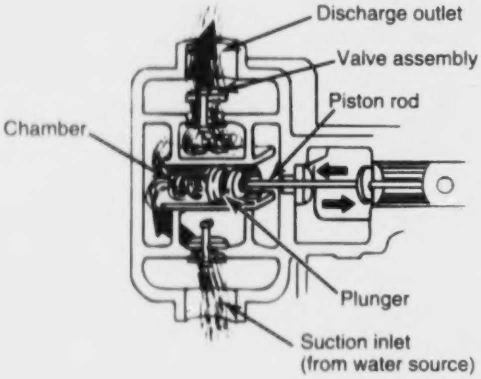
Note: Jet pumps can be either shallow- or deep-well pumps.

5. Operating principles of pumps

a. Piston (reciprocating) pumps

Note: Piston pumps can be installed in small diameter wells and can pump water that contains sand.

- Single acting piston

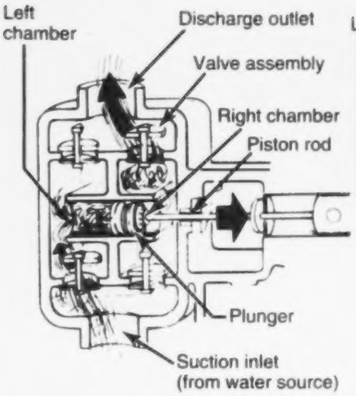


— Suction stroke draws water into the cylinder.

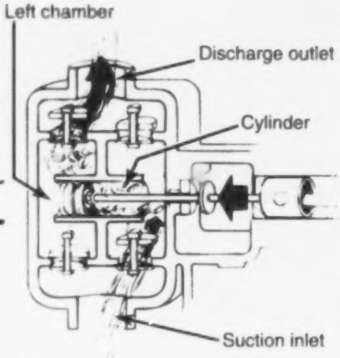
— Discharge stroke pushes water into the discharge pipe.

Information Sheet

- Double acting piston



Movement of plunger to the right



Movement of plunger to the left

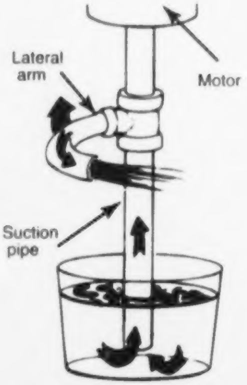
- Movement of the plunger to the right pulls water from the well into the left chamber.
- Water is forced out of the right chamber.
- Plunger movement to the left forces water out of the left chamber.
- Water is pulled from the well into the right chamber.

  Note: The double acting piston provides a constant flow, while the single acting piston provides spurts of water. Piston pumps are "positive acting," discharging the exact amount of water that they draw into their cylinder.

b. Centrifugal pumps

Note: Centrifugal pumps are not designed for high lifts and must be located near the water surface. They are not "positive acting," and their pumping action slips if they encounter too much discharge resistance.

- An L-shaped pipe, completely filled with water and rotated rapidly, will pump water out of a bucket.



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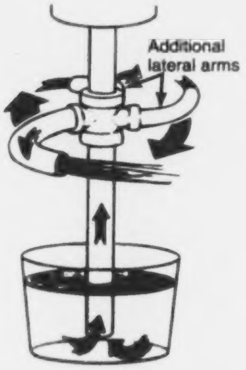
Information Sheet

- Centrifugal pumps must be primed by adding water.
- If the suction pipe and lateral arm are filled with water and then rotated, water in the lateral arm is thrown out by centrifugal force.
- More water can be pumped with addition of lateral arms.



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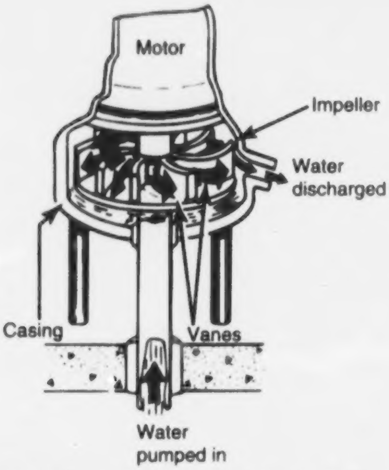
- In a manufactured pump, an impeller replaces the lateral arms.



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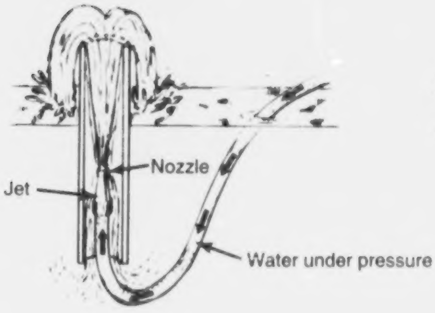
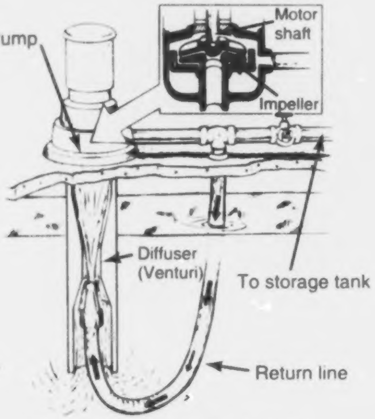
- An impeller is a heavy disk mounted in the pump housing. As the impeller spins, centrifugal force throws water off its outer edge.
- For higher pressures or greater lifts, two or more impellers are used.

c. Jet pumps

- Water is supplied to the jet nozzle under pressure.
- Water surrounding the jet stream is lifted and carried through the pipe as a result of the jet action.





Jet used with a centrifugal pump

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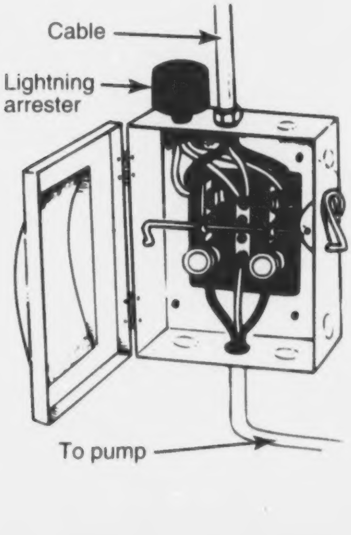
Note: Deep-well centrifugal pumps must use an ejector to raise water more than 25′. Shallow well pumps have improved efficiency if an ejector (jet) is installed. When a jet is used with a centrifugal pump, a portion of the water delivered by the pump is returned to the jet nozzle to operate it. The jet lifts water from the well to a level where the centrifugal pump can finish lifting it by suction.

6. **Pump controls used on private water systems**

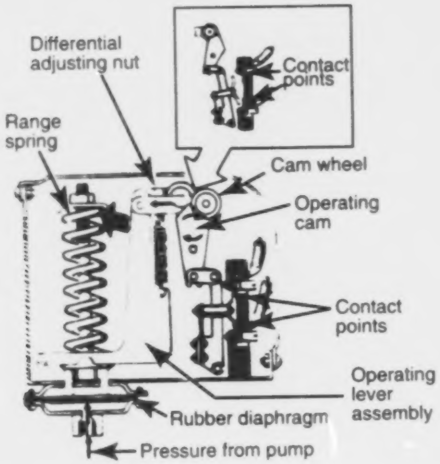
Note: Illustrations in this objective are used with permission of American Association for Vocational Instructional Materials from *Planning for an Individual Water System.*

a. Electrical control box (switch box)

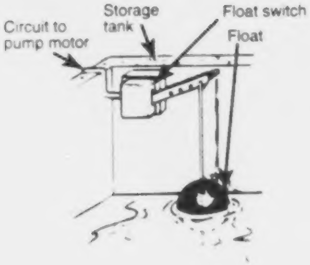


Information Sheet

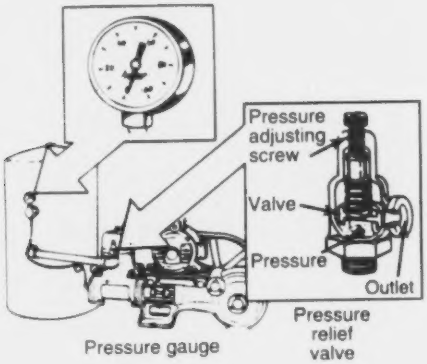
b. Pressure switch



c. Float switch



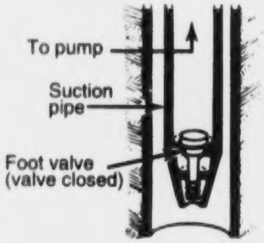
d. Pressure gauge



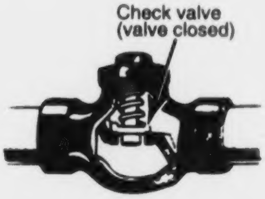
e. Pressure relief valve

Information Sheet

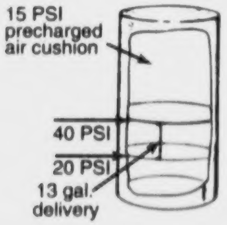
f. Foot valve



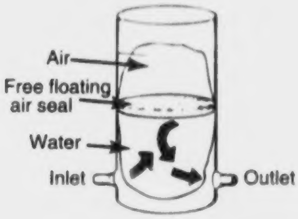
g. Spring-loaded check valve



h. Precharged tank

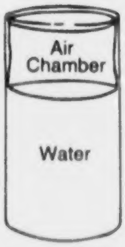


i. Floating air seal

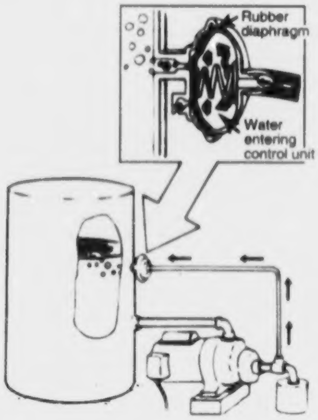


Information Sheet

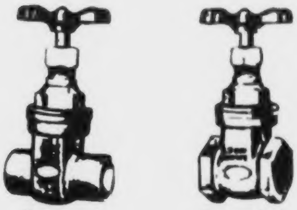
j. Sealed-in air chamber



k. Air volume control



l. Gate valves


Soldered Threaded

7. Applications of pump controls

a. Electrical control box (switch box)

- Pump must be fused separately.
- Master control should be positioned near the pump room entrance in a high, dry location.
- Local control switch should be placed near the pump for manual off-on operation.

Information Sheet

- All electrical wiring must be done according to approved methods, materials, and workmanship.

  Caution: In most cases, a licensed electrician should do the wiring.

b. Pressure switch

- Controls pump operation to determine necessary pressure.
- Most pressure switches are factory set at 20–40 lbs. pressure.

  Note: This means that the switch closes when the pressure drops to 20 lbs. and opens when the pressure builds up to 40 lbs. In some instances, the pressure switch must be adjusted at the time of installation.

- The "differential," the difference between "on" and "off" pressures, is usually 20 lbs.
- A reliable pressure gauge should accompany a pressure switch installation.
- A small socket wrench is a suitable tool for adjusting a pressure switch.

c. Float switch

- Controls pump operation to fill gravity storage tank.
- Float switch operates by float rather than pressure control.

  Note: The float switch operates on the same principle as the water closet control valve.

d. Pressure gauges indicate storage tank pressures.

Note: Pressure gauges are necessary to adjust pressure switches.

e. Pressure relief valves are installed on reciprocating (piston) pumps to relieve excess pressure.

f. Valves control the flow of water throughout a pumping installation.

- Foot valves keep the suction pipe filled with water.
- Check valves keep the storage tank supply from emptying when pump is being repaired.

  Note: Check valves should be installed between pump and tank.

- Gate valves should be used in pump installations to ensure maximum flow of water.

g. Precharging a pressure tank increases the amount of water available between pump stops and starts.

h. Floating air seals help to lower the air absorption rate in pressure tanks.

i. Sealed air chambers keep the air from being absorbed into the water.

Information Sheet

j. Air volume control

- Controls amount of air in pressure tank system.
- Air in tank is compressed when the pump forces water into the tank.

  Note: Water cannot be compressed to any measurable degree.
- When pump stops, compressed air keeps pressure on the water.
- The compressed air pushes the water into the water distribution system.
- Air in the tank is gradually absorbed by the water until very little air space is left.

  Note: Time varies according to tank size.
- The pump will start and stop more frequently due to less air volume.

  Note: This is referred to as a water-logged tank.

Private Water Systems
Unit 1-E

Assignment Sheet 1—Compute the Cost for Plumbing Supplies

Name ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Directions are followed	______
• Total cost is within 5% of instructor's computation	______
• Assignment is neat and completed on time	______

Directions: Using current wholesale catalogs and the materials cost sheets below and on the following page, compute the cost for piping, fittings, pumps, and all other materials needed to complete Job Sheet #1.

ITEM	COST EACH	TOTAL
	SUBTOTAL	

Assignment Sheet 1

ITEM	COST EACH	TOTAL
	SUBTOTAL	
	SUBTOTAL FROM PAGE 19	
	TOTAL	

Private Water Systems
Unit 1-E

Job Sheet 1—Install a Pump and Controls According to Manufacturer's Specifications

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	Rating
• Piping does not leak	______
• Controls operate the system correctly	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Completed job neatly and on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Pump
- Pressure tank
- Three bricks or tank supports
- Two 3/4" galvanized tees
- One 3/4" galvanized iron plug
- One 3/4" galvanized iron 90° elbow
- Assorted 3/4" galvanized iron nipples (2–6", 2–5", 1–4", 2–3")
- Short length 3/4" galvanized iron pipe
- One 3/4" foot valve
- One 3/4" gate valve
- Air volume control
- Pressure switch
- Pressure gauge
- Relief valve (if piston pump is used)
- Bushing for relief valve (if used)
- Two 3/4" galvanized iron unions
- Pipe joint compound
- Two 14" pipe wrenches
- One 8" adjustable wrench
- One 1 1/4" x 1/8" bushing
- Two 1 1/4" x 3/4" bushings
- Short 2" x 8" wood plank (to support pump)
- Pipe threading equipment
- 55 gallon tank
- Boiler drain

Job Sheet 1

B. Procedure

Note: Refer to Figure 1 on last page of this job sheet.

☐ 1. Install 6″ nipple into tank inlet.

Note: This inlet might need a bushing.

☐ 2. Install 5″ nipple into tank outlet.

☐ 3. Install 3/4″ tee on outlet nipple.

☐ 4. Install 3/4″ boiler drain valve on end of tee.

☐ 5. Install 4″ nipple on side outlet of tee (vertical).

☐ 6. Install 3/4″ gate valve on end of nipple.

Note: Apply pipe compound to all male threads.

☐ 7. Install 3/4″ union on end of tank inlet nipple.

☐ 8. Raise pressure tank up to rest on bricks or supports.

☐ 9. Raise pump up to rest on work plank.

Note: Use any material to cushion vibration.

☐ 10. Measure distance from pump outlet to tee (end to center measurement).

☐ 11. Cut, ream, and thread discharge pipe.

☐ 12. Install discharge pipe in pump outlet.

☐ 13. Loosen union and install on pump discharge pipe (installed in Step 12).

☐ 14. Tighten union.

☐ 15. Install 3″ nipple in suction side of pump.

☐ 16. Install 3/4″ union, 3″ nipple, elbow, 3″ nipple, and foot valve.

☐ 17. Install pressure control.

☐ 18. Install air volume control (including tubing).

☐ 19. Install gauge.

Job Sheet 1

☐ 20. Ask your instructor to check your work.

☐ 21. Clean tools and work area and return all equipment and materials to their proper places.

Note: Installation can be tested using 55 gallon drum filled with water.

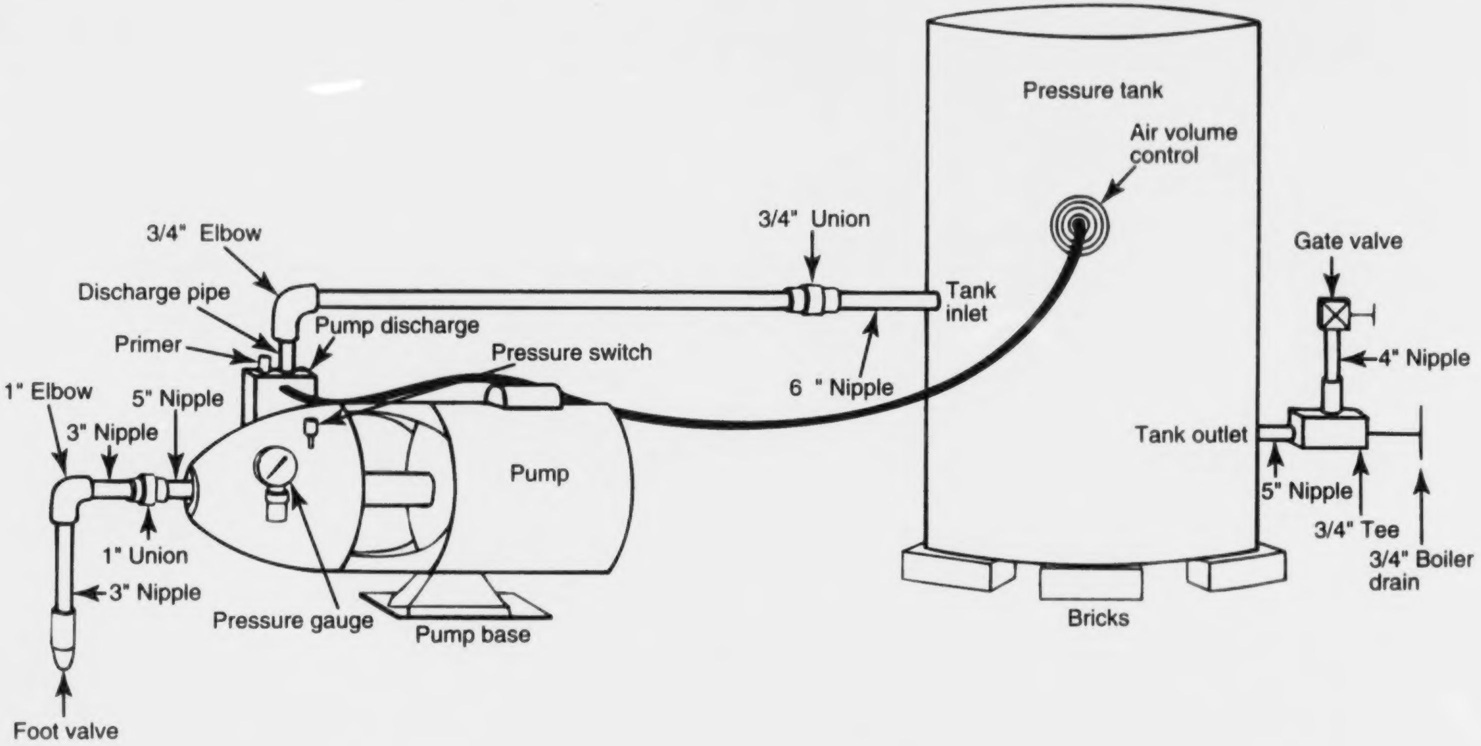
Evaluator's Comments: ______________________________

____

____

Private Water System

Figure 1



Job Sheet 1

Septic Systems
Unit 2-E

Objective Sheet

Unit Objective

After completing this unit, the student should be able to install a septic tank. The student should demonstrate these competencies by completing the job sheet and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to septic systems with their definitions.
2. Complete statements concerning the operation of a septic system.
3. Select true statements concerning the basic design of a septic system.
4. List septic tank construction materials.
5. Select true statements concerning septic tank care.
6. Install a septic tank. (Job Sheet 1)

Septic Systems
Unit 2-E

Information Sheet

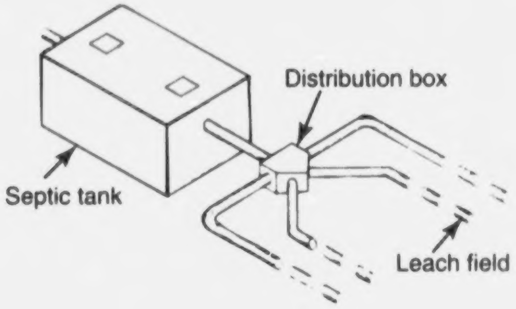
1. **Terms and definitions**

   a. **Aerobic bacteria**—Bacteria that live and grow in the presence of oxygen

   b. **Anaerobic bacteria**—Bacteria that live and grow in the absence of oxygen

   c. **Cesspool**—A pit or well constructed of brick, stone, or block, without any masonry (cement bond), used to receive sewage discharge from a building

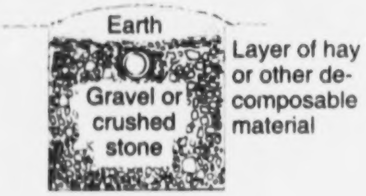
   d. **Distribution box**—A small tank taking the immediate discharge of the septic tank and distributing it in two or more directions



   e. **Effluent**—The clear liquid discharge which flows out of a septic tank

   f. **Lagoon**—Small pond taking the effluent from the septic tank when leach field drainage is insufficient

   g. **Leach field**—A piping installation designed to disperse the septic tank discharge into the soil to be evaporated or absorbed



Cross Section of Leach Field

   h. **Leaching pit**—A perforated masonry tank used to disperse the effluent from a septic tank

   i. **Percolation test**—A test to determine the ability of the soil to absorb water

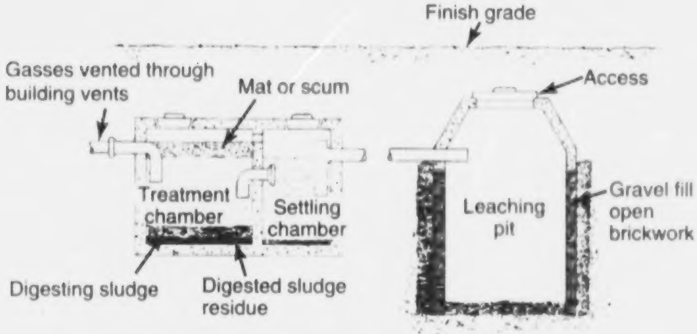
Information Sheet

j. **Perforated pipe**—Pipe with holes in the side which allow liquid to be released into the ground

k. **Septic**—Destructive action of bacteria on organic matter

Note: An antiseptic such as a mouthwash kills bacteria and counteracts the destructive action.

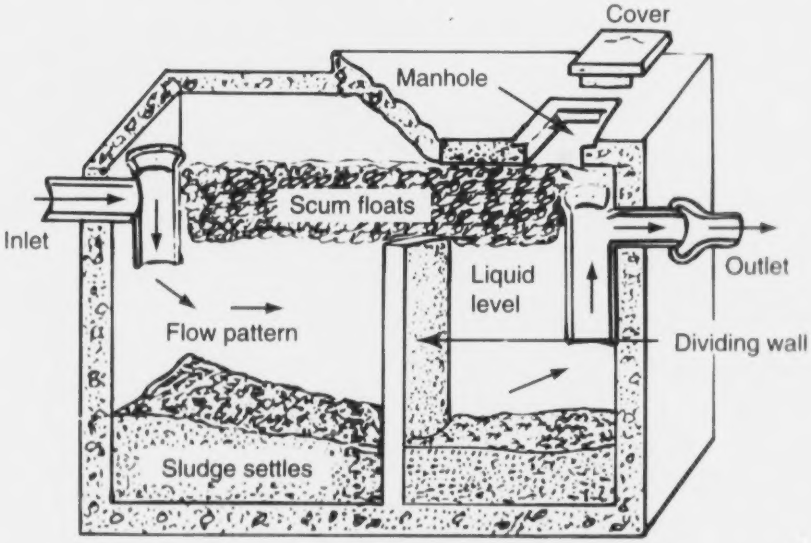
l. **Septic tank**—A waterproof tank in a private sewage disposal system that promotes the growth and reproduction of bacteria in order to break up and decompose organic matter



Two-Compartment Septic Tank

m. **Sludge**—Solids that settle to the bottom of a tank or pit

2. Operation of a septic system



a. The septic tank receives the discharge from soil pipes which extend beyond the building walls.

b. Organic solids settle to bottom of tank.

Information Sheet

c. Bacteria decompose the solids and clarify the liquid effluent.

d. The effluent leaves the septic tank by gravity and enters the leaching field.

e. The effluent is dispersed into the soil, sand, and/or gravel to be evaporated at the ground surface or to be drained into the ground.

3. Basic design of a septic system

Note: Refer to local codes.

a. The sewage disposal system should consist of a septic tank with effluent discharging into a subsurface tile system.

b. All waste water must be connected to the disposal system, including laundry and kitchen wastes.

c. Septic systems are designed for a maximum water usage of 8,000 gallons per month for 2- or 3-bedroom residences and 10,000 gallons per month for 4-bedroom residences.

Note: Systems using more than this amount of water cannot be expected to perform properly.

d. All parts of the disposal system should be located at least 50′ from any water supply when the ground slopes from the water well and conditions are favorable.

Note: When ground elevations or other unfavorable conditions indicate danger to a water supply, this distance should be increased to 100′ or more.

e. All parts of the sewage disposal system except the septic tank and connecting house sewer (i.e., subsurface tile, distribution, or retention boxes) should be located at least 10′ from dwellings, garages, or other structures, and 15′ from water lines.

f. The septic tank should be located a minimum of 5′ from dwellings, garages, or other structures.

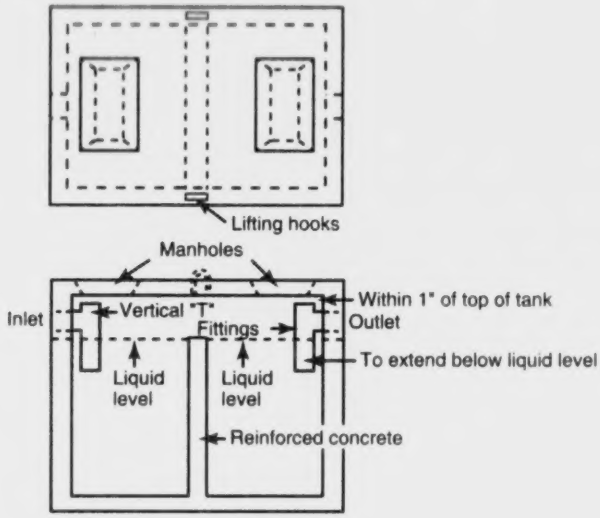
g. Under favorable drainage and soil conditions, all parts of the system should be located a minimum of 5′ from property lines.

h. The minimum size septic tank shall be 1,000 gallons liquid capacity for each dwelling or living unit with 4 or fewer bedrooms, with 250 gallons additional liquid capacity for each additional bedroom above 4.

Note: For special situations, 500 gallon tanks might be acceptable.

4. Septic tank construction materials

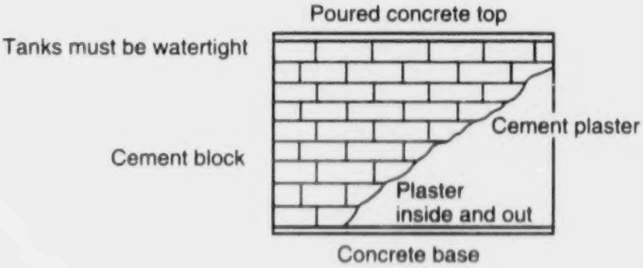
a. Reinforced (wire mesh) concrete



Typical Precast Concrete Tank
3000 lbs. Minimum Strength Concrete

b. #12 gauge steel, coated with bituminous material

c. Cement blocks



d. Fiberglass

e. Reinforced plastic

5. Septic tank care

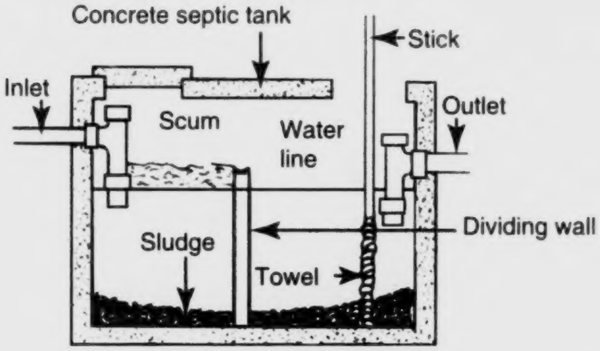
a. There is no set period of time to clean out a septic tank, but it should be checked every two years to determine if cleaning is necessary.

b. To determine when the septic tank needs to be cleaned, use the following procedure:

- Wrap and nail cloth toweling to the bottom 3′ of a piece of lumber 1″ x 2″ x 8′.
- Remove the septic tank's cover or inspection port.

Information Sheet

- Slowly lower the toweled end of the board into the tank until it reaches the bottom of the tank.
- Hold in this position for several minutes, then remove the measuring device from the tank as gently as possible.



- The dark-colored sludge will discolor the toweling, denoting the total depth of sludge accumulation.
- When the sludge is more than 24″ deep, it is time to have the septic tank cleaned by a licensed septic tank cleaner.
- A gallon of sludge should be left in the tank for a bacterial starter.

  Note: The addition of yeast, enzymes, bacteria, etc., is not necessary for digestion within the tank.

- The normal use of bleaches, detergents, soaps, and drain cleaners does not harm or interfere with the operation of the system.

  Note: The scum forming on top of the liquid often becomes so thick that it limits the effectiveness of the system. The scum must then be removed.

Septic Systems
Unit 2-E

Job Sheet 1—Install a Septic Tank

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Top of septic tank is at least 8″ below finished grade	______
• Followed proper procedures for installing septic tank	______
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Task is completed in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Builder's level and tripod
- 6′ rule or steel tape
- Backhoe and operator
- Pointed shovel
- Sledge hammer
- Level
- Roll of roofing felt
- Drain pipe
- Sand, cement, and water
- Small pointed shovel
- Septic tank and top

B. Procedure

Note: Refer to local codes.

☐ 1. Using a builder's level, establish grade at drain pipe stubbed out of building.

☐ 2. Measure distance from building stub to point where drain line will enter tank.

Note: Allow for a 1/4″ slope per foot of drain line.

☐ 3. Measure septic tank and determine required depth of hole.

☐ 4. Dig hole to required depth, width, and length with backhoe.

Note: Remove earth as necessary with a shovel.

Caution: Demonstrate extreme caution while in or near excavating site.

Job Sheet 1

☐ 5. Lift the tank and position it in hole with the backhoe.

☐ 6. Level the tank, checking the length and width.

☐ 7. Connect drain to septic tank using sand, cement, and water mixture.

Note: Make a neat joint at the tank, using a small pointed trowel.

☐ 8. Cover top of tank with roofing felt.

☐ 9. Pack earth firmly around sides and top of tank.

☐ 10. Remove excess earth.

☐ 11. Ask your instructor to check your work.

☐ 12. Clean tools and work area and return all equipment and materials to their proper places.

Note: In poor drainage soils, tanks should be partially filled with water; even concrete tanks can float after severe rains.

Evaluator's Comments: ______________________________

____

____

Water Treatment
Unit 3-E

Objective Sheet

Unit Objective

After completing this unit, the student should be able to identify methods of disinfecting water and prepare a water sample for analysis by a state testing laboratory. The student should demonstrate these competencies by completing the job sheet and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to water treatment with their definitions.
2. Identify five methods of disinfecting water.
3. State the probable causes of poor water quality symptoms.
4. Match poor water conditions with the means used to control them.
5. Prepare a water sample for analysis by a state testing laboratory. (Job Sheet 1)

Water Treatment
Unit 3-E

Information Sheet

1. **Terms and definitions**

   a. **Contamination**—A source which makes water unwholesome, impure, or undesirable for use or consumption

   b. **Corrosive**—Weakening or destroying by chemical action

   c. **Demand**—Chlorine used up in reaction to organic matter

   d. **Dosage**—Total amount of chlorine added to water in parts per million (ppm)

   e. **Ion**—Atom or group of atoms that carry an electrical charge

   f. **Ion exchange**—The process of exchanging the hard calcium and magnesium ions for soft sodium ions

   g. **Osmosis**—The passage of fresh water through a special membrane into the side of a tank containing salt water

   h. **Pollution**—Physical sources that contaminate water

   i. **Residual**—Amount of chlorine solution that is left over after its killing action is "used up"

   j. **Reverse osmosis**—By applying pressure to water on the side containing salt or hardness particles, water is forced to move back through the membrane, cleansing it of soluble materials

   k. **Safe water**—Water that is relatively free from harmful bacteria, viruses, parasites, and radiation

   l. **Water conditioning**—Correcting quality problems of water supply

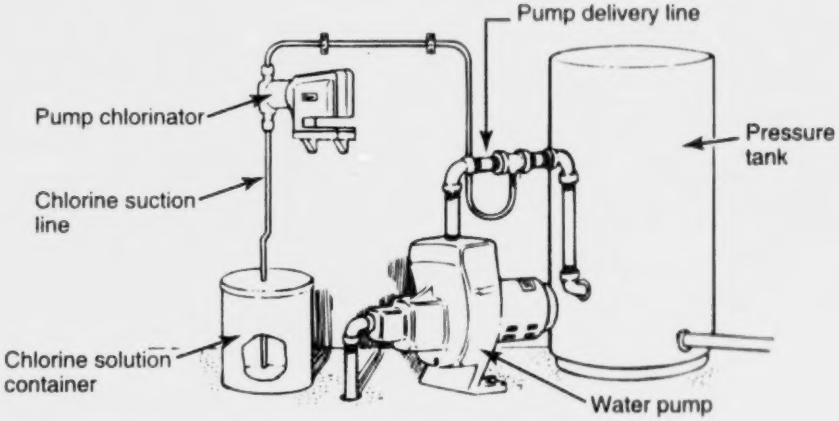
   m. **Zeolite**—Sand-like water softening material

Information Sheet

2. Methods of disinfecting water

a. Chlorine method (by injecting into water)

- Pump chlorinator



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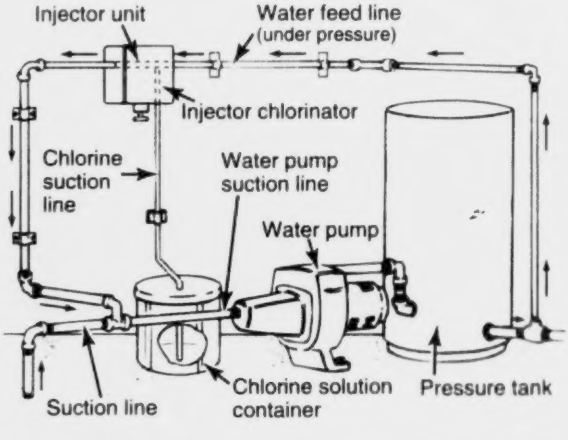
- Injector chlorinator



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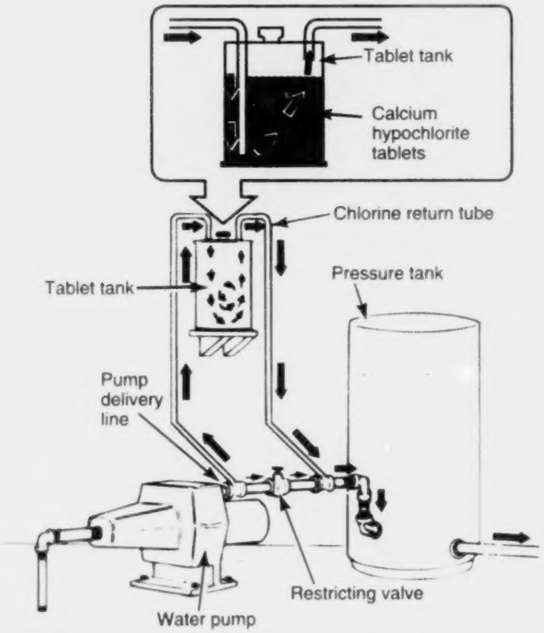
Information Sheet

- Tablet chlorinator

Note: One to five parts of chlorine are added to 1,000,000 parts of water. This is commonly referred to as parts per million, or "ppm."



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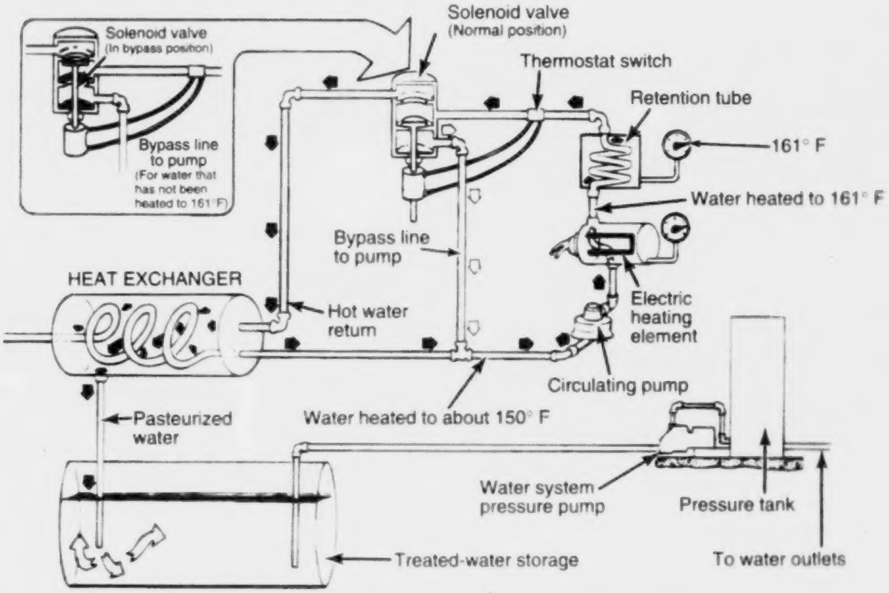
b. Pasteurization method



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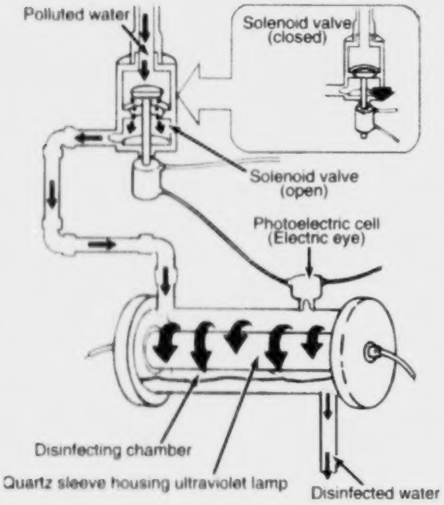
Information Sheet

c. Ultraviolet light method

Note: The killing action is the same as that provided by sunlight in killing bacteria in open streams.



3. Symptoms and probable causes of poor water quality

a. Hardness

- Symptoms
  - Sticky curd forms when soap is added to water
  - Causes well-recognized ring in bathtub
  - The harder the water, the more soap is required to form suds
  - Glassware appears streaked and murky
  - Hard, scaly deposits form inside metal pipes
  - Skin roughens from washing
- Probable causes
  - Calcium and magnesium in the water

    Note: This may be in the form of bicarbonates, sulfates, or chlorides.
  - Iron

Information Sheet

b. Red water

- Symptoms
  - Red stains appear on clothes and porcelain plumbing fixtures
  - Causes corrosion of steel pipes
  - Water has metallic taste
  - Freshly-drawn water sometimes appears clear at first, but after exposure to air, rust particles form and settle to bottom of container
  - Red slime develops in toilet tanks
- Probable causes
  - Dissolved iron (sometimes called manganese)

    Note: This is caused by the dissolving action of water as it passes through underground iron deposits or contacts iron and steel surfaces.
  - Iron bacteria

    Note: Iron bacteria is caused by living organisms (bacteria) that act on iron already in the water. This is often associated with acid or other corrosive conditions.

c. Brownish-black water

- Symptoms
  - Fixtures stain brownish-black
  - Fabrics stain black
  - Coffee and tea have bitter taste
- Probable causes
  - Manganese present, usually along with iron
  - Manganese bacteria

d. Acidity

- Symptoms
  - "Eats away" copper and steel parts on pump, piping, tank, and fixtures
  - If copper or brass is being "eaten," water may leave green stains on plumbing fixtures under a dripping faucet
  - If water contains iron, iron-removal methods are less effective

- Probable causes
    - Water contains carbon dioxide picked up from air or from decaying vegetable matter that combines with water to form a weak acid
    - In rare instances, water may contain mineral acid such as sulfuric, nitric, or hydrochloric acids

e. "Rotten egg" odor and flavor

- Symptoms
    - "Eats away" copper and steel parts on pump, piping, tank, and fixtures
    - If sulfur and iron are both present in water, finely-divided black particles may develop; commonly called "black water"

      Note: Silverware turns black.
    - Not satisfactory for cooking
- Probable causes
    - Hydrogen-sulfide gas
    - Sulfate-reducing bacteria
    - Sulfur bacteria

f. Other off flavors

- Symptom—Water may taste bitter, oily, salty, or have a chlorine odor or taste
- Probable causes
    - Extremely high mineral content
    - Presence of organic matter
    - Excess chlorine
    - Water passing through areas containing salty or oily waste

g. Turbidity

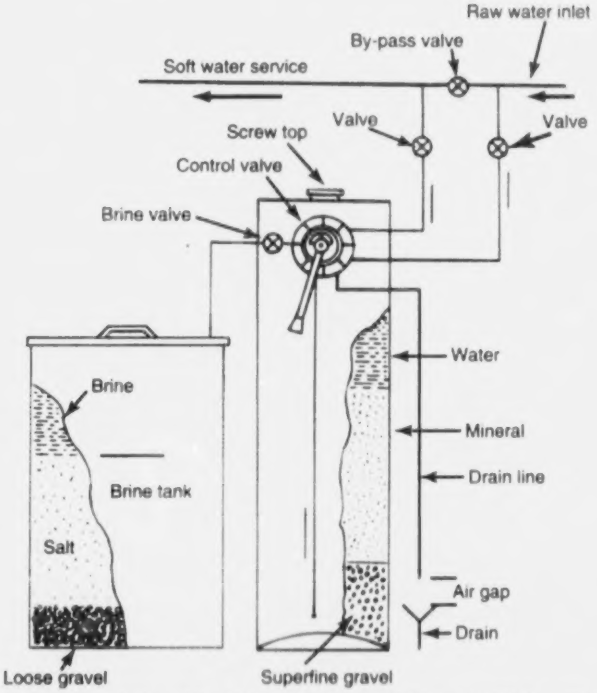
- Symptom—Water with a dirty or muddy appearance
- Probable causes
    - Silt
    - Sediment
    - Small organisms
    - Organic matter

Information Sheet

4. Means of controlling water quality

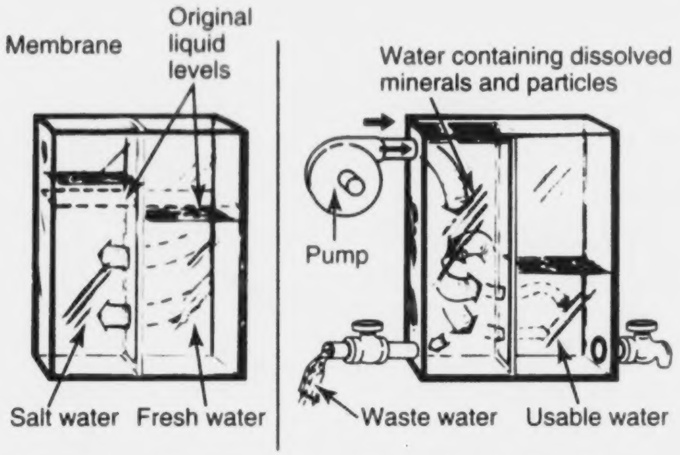
a. Hard water

- Water softener



Used with permission of the Ontario Ministry of Colleges and Universities from *Steamfitting, Module D-1, Valves.*

- Reverse-osmosis unit



Osmosis **Reverse Osmosis**

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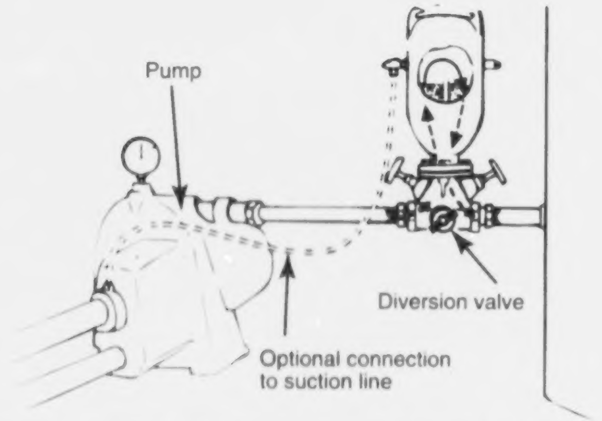
b. Iron

- Phosphate feeder



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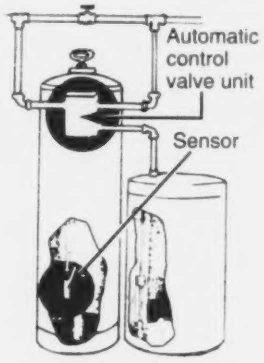
- Ion-exchange units (zeolite water softeners)



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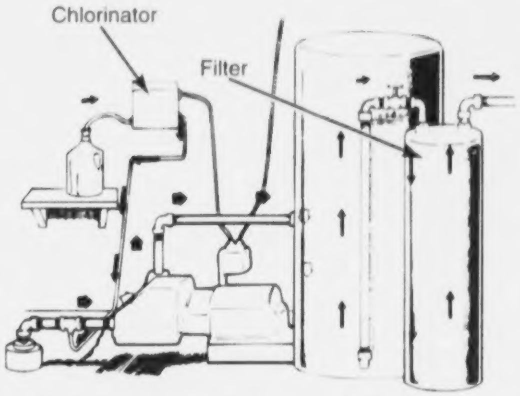
- Oxidizing filters (water softener using manganese-treated green sand)

Information Sheet

- Chlorinator-and-filter units



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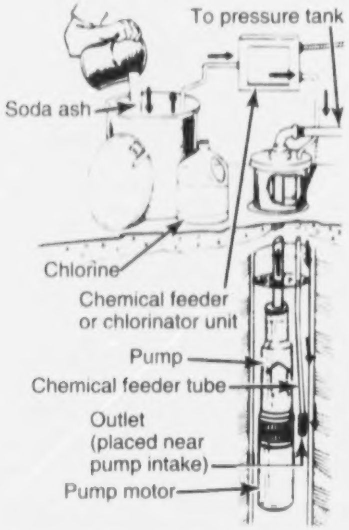
c. Manganese

- Phosphate feeder
- Ion-exchange units
- Oxidizing filters
- Chlorinator-and-filter units

d. Acid water—Soda ash or caustic-soda feeder


To pressure tank
Soda ash
Chlorine
Chemical feeder or chlorinator unit
Pump
Chemical feeder tube
Outlet (placed near pump intake)
Pump motor

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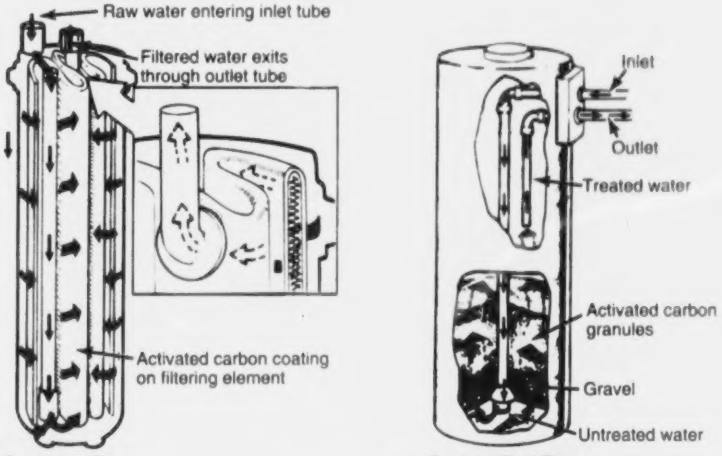
Information Sheet

e. Off flavor—Activated carbon filter (cartridge type or carbon bed type)


Raw water entering inlet tube
Filtered water exits through outlet tube
Activated carbon coating on filtering element
Inlet
Outlet
Treated water
Activated carbon granules
Gravel
Untreated water

Cartridge Type

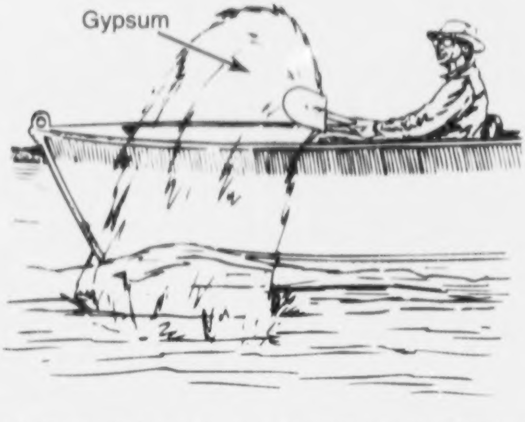
Carbon Bed Type

Used with permission of American Association for Vocational Instructional Materials.

f. Turbidity

- Open pond treatment

  Note: Gypsum may be applied to pond surface to clear turbidity without killing fish or other marine life.



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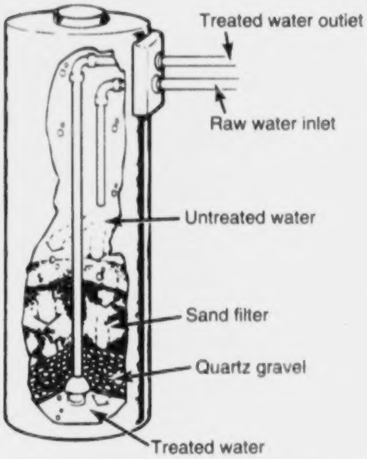
Information Sheet

- Treatment systems
  - Sedimentation and filtering system
  - Diatomite filter
  - Rapid sand filter



Used on the pressure side of a pump for filtering out suspended dirt particles

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Water Treatment
Unit 3-E

Job Sheet 1—Prepare a Water Sample for Analysis by a State Testing Laboratory

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	Rating
• Demonstrated proper safety precautions	______
• Followed correct procedure for filling bottle	______
• Properly sealed bottle	______
• Correctly packaged bottle for mailing	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- 3–5 ounce bottle with cap
- Pan
- Material to safely package bottle
- Source of cold running tap water

B. Procedure

☐ 1. Select a cold-water faucet.

☐ 2. Place bottle and cap in pan of cold water and raise the temperature of the water to boiling.

☐ 3. Boil water for ten minutes to sterilize the bottle.

☐ 4. Remove any hose or attachment from the water faucet if one is present.

☐ 5. Run water full flow for about two minutes.

☐ 6. Reduce flow to about one-third of full flow.

☐ 7. Fill sterile bottle to within one-half inch of top.

☐ 8. Cap bottle tightly with sterile cap.

☐ 9. Package for mailing.

☐ 10. Ask your instructor to check your work.

☐ 11. Mail or deliver sample immediately to the laboratory.

Job Sheet 1

☐ 12. Clean work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

____

____

Fuel Piping Systems
Unit 4-E

Objective Sheet

Unit Objective

After completing this unit, the student should be able to size a gas pipe for residential construction and perform leak tests on gas supply lines. The student should demonstrate these competencies by completing the assignment sheet and the job sheet and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to fuel piping systems with their definitions.
2. Select materials for pipe, fittings, and valves which are commonly used in fuel piping systems.
3. Distinguish among methods of joining fuel piping for different types of materials.
4. Select true statements concerning basic principles of natural gas codes.
5. Complete statements concerning fuel piping testing methods.
6. Size a gas pipe for residential construction. (Assignment Sheet 1)
7. Perform leak tests on gas supply lines. (Job Sheet 1)

Fuel Piping Systems
Unit 4-E

Information Sheet

1. **Terms and definitions**

    a. **Administrative authority**—Local government board which administers gas code enforcement

    b. **AGA**—American Gas Association

    c. **Appliance fuel connector**—An assembly of semi-rigid or flexible tubing and fittings to carry fuel between a fuel piping outlet and a fuel-burning appliance

    d. **ASTM**—American Society for Testing and Materials

    e. **BTU**—British thermal unit; the amount of heat needed to raise one cubic foot of water one degree Fahrenheit

    f. **CFH**—Cubic feet per hour

    g. **Ferrous**—Metals having iron as their base such as steel and cast iron

    h. **Inert gas**—Gas which has a low reaction to high pressures, high temperatures, flames, or sparks

    i. **LPG**—Liquefied petroleum gas; a petroleum product

    j. **Manufactured gas**—Gas usually made from petroleum and natural gas combinations

    k. **Natural gas**—Gas as it comes from the earth, refined and piped directly to the consumer

    l. **Nonferrous**—Metals containing no iron such as copper, brass, and aluminum

2. **Materials used in fuel piping systems**

    Note: All materials used for fuel piping systems must be clean and unused.

    a. Pipe

    Note: All pipe used for fuel gas must bear the manufacturer's name or trademark, pipe size, designation code, and ASTM specifications.

    - Wrought steel

        Note: Wrought steel is commonly referred to as "black iron."

    - Copper tubing

        Note: Type K or L is used only for LPG.

Information Sheet

- Plastic
  - PE—Polyethylene, Type II, III
  - PVC—Polyvinyl chloride, Type I, II

  Note: PE and PVC are used only underground.

b. Fittings and valves

- Wrought steel
- Brass
- Plastic

3. Methods of joining fuel piping

a. Black steel (Schedule 40)

- Threaded
- Flanged
- Welded

b. Copper—Flared

c. Plastic

- Solvent welded
- Heat fusion (welded)
- Compression
- Flanged

Note: Recommendations of the pipe manufacturer for joining and use of plastic pipe must be considered.

4. Basic principles of natural gas codes

Note: Refer to local codes.

a. All joints in the piping system, unless welded, shall be screwed joints, having approved standard thread.

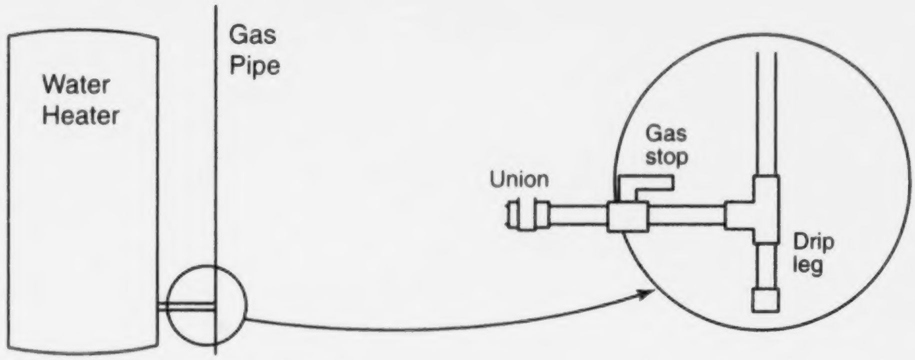
Note: Such screwed joints shall be made up with approved pipe joint material, insoluble in the presence of fuel gas and applied to the male threads only.

Information Sheet

b. No gas piping shall be installed in or on the ground under any building or structure, and all exposed gas piping shall be kept at least 6″ above grade or structure.

Note: When necessary due to structure conditions, approved type gas piping may be installed in other locations when permission has first been obtained from the administrative authority.

c. Where water vapor is present in the fuel gas served, accessible drip pipes shall be provided at points where condensation will tend to collect.



d. Ferrous gas piping installed underground in exterior locations shall be protected from corrosion by approved coatings or wrapping materials and all such horizontal piping shall have at least 12″ of earth cover or other equivalent protection.

Note: Risers shall be wrapped to a point at least 6″ above grade.

e. All gas pipe protective coatings shall be approved types, machine applied, and conform to recognized standards.

f. Field wrapping shall provide equivalent protection and is restricted to those short sections and fittings necessarily stripped for threading or welding.

g. Zinc coatings (galvanizing) shall not be deemed adequate protection for piping below ground.

h. Ferrous metals in exposed exterior locations shall be protected from corrosion in a manner satisfactory to the administrative authority.

Information Sheet

i. All gas piping shall be adequately supported by metal straps or hooks at intervals not to exceed those shown in Table 1.

Table 1. Support of Piping

Size of Pipe (Inches)	Feet
1/2″	6
3/4″ or 1″	8
1 1/4″ or larger (Horizontal)	10
1 1/4″ or larger (Vertical)	Every floor level

j. Gas piping installed below grade shall be effectively supported at all points on undisturbed or well compacted soil. Gas piping should be deep enough to protect pipe from damage from sharp tools and be below frost line.

k. Material used for backfill around the pipe shall be free of rocks, building materials, ashes, and trash.

l. Gas piping supplying more than one building on any one premise shall be equipped with separate shutoff valves to each building, so arranged that the gas supply can be turned on or off to any individual or separate building.

m. Such shutoff valve shall be located outside the building it supplies and shall be readily accessible at all times.

n. Where unions are necessary, right and left nipples and couplings shall be used.

o. Ground-joint unions may be used at exposed fixture, appliance, or equipment connections, and in exposed exterior locations immediately on the discharge side of a building shutoff valve.

Note: Heavy duty flanged type unions may be used in special cases when first approved by the administrative authority.

p. Bushings shall not be used.

q. Valves used in connection with gas piping shall be approved types.

r. An accessible shutoff valve shall be installed in the fuel supply piping outside of each appliance and ahead of the union connection thereto, and in addition to any valve on the appliance.

Note: Shutoff valves shall be within 3′ of the appliance.

s. Shutoff valves may be located immediately adjacent to and inside or under an appliance when placed in an accessible and protected location and when such appliance may be removed without removal of the valve.

Information Sheet

t. Shutoff valves may be accessibly located inside wall heaters and wall furnaces listed for recessed installation where necessary maintenance can be performed without removal of the shutoff valve.

u. Appliance connections shall at no time have a diameter less than that of the inlet connection to the appliance as provided by the manufacturer.

v. A gas appliance may be connected with an approved listed metal appliance connector under the following conditions:

- Listed metal appliance connectors shall have an overall length not to exceed 3′.

  Note: A range connector may exceed 3′, but cannot exceed 6′.

- No part of such connector shall be concealed within or extended through any wall, floor, or partition.
- A listed accessible appliance connector valve, not less than the nominal size of the connector, shall be provided at the gas piping outlet immediately ahead of the connector.
- All connectors shall be of such size as to provide the total demand of the connected appliance.
- Aluminum alloy connectors may be used in interior locations where they shall not be in contact with masonry, plaster, or insulation, or are not subject to repeated corrosive wettings.

5. Fuel piping testing methods

a. Applying pressure

- The system should be filled with air or inert gas.

  Caution: Never use pure oxygen because it becomes explosive when in contact with oil or grease.

- Gas piping should withstand a pressure of at least 6″ of mercury measured with a manometer for a period of not less than 10 minutes without showing a drop in pressure.

  Note: High pressure piping requires 10″ of mercury, and all piping should be tested at no less than twice the maximum pressure to which the piping will be subjected in operation.

b. Checking for leaks

- Leaks can be located by applying soap and water to the piping joints.
- Fire or acid should not be used to locate leaks.
- Water should not be introduced into the piping system for any purpose.

Fuel Piping Systems
Unit 4-E

Assignment Sheet 1—Size a Gas Pipe for Residential Construction

Name ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Directions are followed	______
• Followed procedure correctly	______
• Answers are correct	______
• Assignment is neat and completed on time	______

The procedure for sizing fuel pipe for residential construction is outlined below. Read the procedure and study the example. When you are familiar with the procedure, complete the problem provided in Section B.

A. **Procedure**

1. From Table 1, determine cubic feet of gas to be consumed for each outlet.

   Note: 1,100 BTU per cubic foot is the standard of measurement used in sizing fuel pipes.

   Table 1

   Minimum Demand of Typical Gas Appliances (in BTU per hour)

Appliance	Demand
Domestic gas range	65,000
Domestic recessed top burner section	40,000
Domestic recessed oven section	25,000
Storage water heater—up to 30-gal. tank	30,000
Storage water heater—40 to 50 gal. tank	50,000
Domestic clothes dryer	35,000
Fireplace log lighter (residential)	25,000
Fireplace log lighter (commercial)	50,000
Barbecue (residential)	50,000
Gas refrigerator	3,000
Bunsen burner	3,000
Gas engines (per horsepower)	10,000
Steam boilers (per horsepower)	50,000

2. Measure the length of the pipe from the gas meter to the most remote outlet on the system.

Assignment Sheet 1

Table 2

Size of Gas Piping
Maximum delivery capacity in cubic feet of gas per hour (CFH)
of IPS pipe carrying natural gas of 0.65 specific gravity.
Based on pressure drop 0.5 inch water column.

Length in Feet

Pipe Size	10′	20′	30′	40′	50′	60′	70′	80′	90′	100′	125′
1/2″	170	118	95	80	71	64	60	55	52	49	44
3/4″	360	245	198	169	150	135	123	115	108	102	92
1″	670	430	370	318	282	255	235	220	205	192	172
1 1/4″	1,320	930	740	640	565	510	470	440	410	390	345
1 1/2″	1,990	1,370	1,100	950	830	760	700	650	610	570	510
2″	3,880	2,680	2,150	1,840	1,610	1,480	1,350	1,250	1,180	1,100	1,000
2 1/2″	6,200	4,120	3,420	2,950	2,600	2,360	2,180	2,000	1,900	1,800	1,600
3″	10,900	7,500	6,000	5,150	4,600	4,150	3,820	3,550	3,300	3,120	2,810
3 1/2″	16,000	11,000	8,900	7,600	6,750	6,200	5,650	5,250	4,950	4,650	4,150
4″	22,500	15,500	12,400	10,600	9,300	8,500	7,900	7,300	6,800	6,400	5,700

Pipe Size	150′	200′	250′	300′	350′	400′	450′	500′	550′	600′
1/2″	40	34	30	27	25	23	22	21	20	19
3/4″	83	71	63	57	52	48	45	43	41	39
1″	158	132	118	108	100	92	86	81	77	74
1 1/4″	315	270	238	215	200	185	172	162	155	150
1 1/2″	460	400	350	320	295	275	255	240	230	220
2″	910	780	690	625	570	535	500	470	450	430
2 1/2″	1,450	1,230	1,100	1,000	920	850	800	760	720	690
3″	2,550	2,180	1,930	1,750	1,600	1,500	1,400	1,320	1,250	1,200
3 1/2″	3,800	3,200	2,860	2,600	2,400	2,200	2,100	2,000	1,900	1,800
4″	5,200	4,400	3,950	3,600	3,250	3,050	2,850	2,700	2,570	2,450

3. Locate the column in Table 2 showing that distance or the next longer distance if the table does not give the exact length.

4. In that column, find the gas demand for the most remote outlet.

   Note: If the exact figure of the demand is not shown, choose the next larger figure below in the column.

5. In the row for the correct demand, locate the appropriate pipe size in the first column to the left.

6. Follow the same procedure to size each section of branch piping:

   a. Determine the total gas demand for each section of pipe.

   b. Locate in column 1 the correct size of pipe for that section.

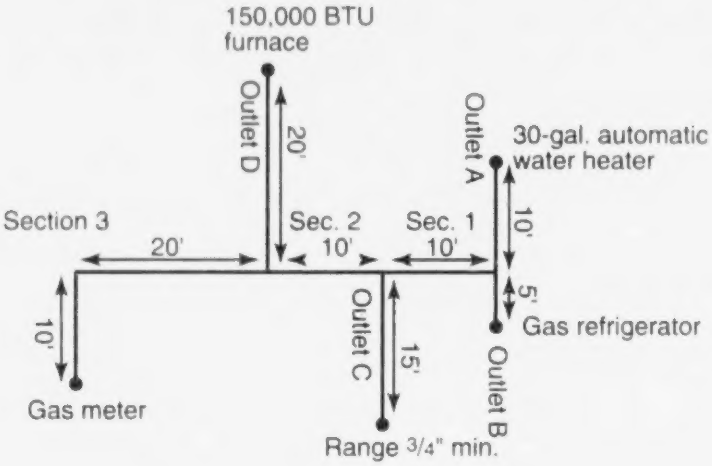
Assignment Sheet 1

Example:

Determine the required pipe size of each section and outlet of the fuel pipe system shown in Figure 1.

Note: Gas to be used has 1100 BTU per cubic foot, and all other considerations are normal.

Figure 1



1. Use Table 1 to determine the cubic feet of gas that each outlet will consume.
    a. Maximum gas demand of outlet A = 30,000 BTU/1100 = 27 cu. ft. per hour.
    b. Maximum gas demand of outlet B = 3,000 BTU/1100 = 3 cu. ft. per hour.
    c. Maximum gas demand of outlet C = 65,000 BTU/1100 = 59 cu. ft. per hour.
    d. Maximum gas demand of outlet D = 150,000 BTU/1100 = 136 cu. ft. per hour.
2. Measure the length of pipe from the gas meter to the most remote outlet on the system.

    Note: The length of pipe from the gas meter to the most remote outlet (Outlet A) is 60′.
3. Find the column in Table 2 for that distance, or the next longer distance if the table does not give the exact length.
4. In that column, find the gas demand for the most remote outlet.

    Note: If the exact figure for the demand is not shown, use the next larger figure below in that column.
5. Locate the correct size of pipe for that demand in column 1; Outlet A, 60′ from the gas meter and supplying 27 CFH, requires 1/2″ pipe.

Assignment Sheet 1

6. Follow the same procedure to determine the demand for each section of pipe serving this outlet.

   a. Determine the total gas demand for each section of pipe.

   b. Locate the correct size of pipe for that demand in Table 2, column 1.

      - Section 1, supplying outlets A (27 CFH) and B (3 CFH), total 30 CFH, requires 1/2″ pipe.

      - Section 2, supplying outlets A (27 CFH), B (3 CFH), and C (59 CFH), total 89 CFH, requires 3/4″ pipe.

      - Section 3, supplying outlets A (27 CFH), B (3 CFH), C (59 CFH), and D (136 CFH), total 225 CFH, requires 1″ pipe.

7. Size each section of branch piping not previously sized by following the same procedure.

   a. Measure the distance from the gas meter to the most removed outlet in that branch.

   b. Use Table 2 to determine the correct size of pipe for that branch.

      - Outlet B, 55′ from the meter and supplying 3 CFH, requires 1/2″ pipe.

      - Outlet C, 55′ from the meter and supplying 59 CFH, requires 3/4″ pipe because range connections are a standard 3/4″.

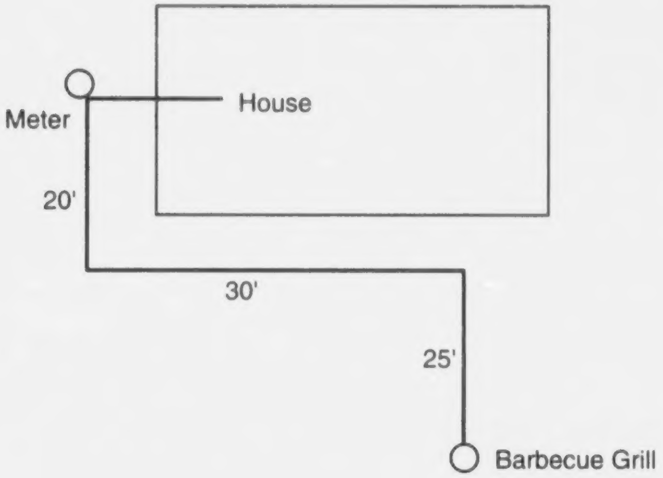
      - Outlet D, 50′ from the meter and supplying 136 CFH, requires 3/4″ pipe.

Assignment Sheet 1

B. **Problem**

Directions: SIze gas pipe for the residential construction shown in Figure 2. Write your answers in the blanks provided.

Figure 2



1. Maximum gas demand for barbecue grill (from Table 1) ______________________
2. Total distance of gas line (from Figure 2) ______________________
3. Pipe size for barbecue (from Table 2) ______________________

Fuel Piping Systems
Unit 4-E

Job Sheet 1—Perform Leak Tests on Gas Supply Lines

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Demonstrated proper safety precautions	______
• Demonstrated correct use of tools and materials	______
• Demonstrated quality of workmanship	______
• Followed procedure correctly	______
• Completed task on time	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Air compressor
- Pressure gauge and pipe fittings
- Pipe wrenches
- Pipe joint compound

B. Procedure

☐ 1. Cap all gas risers.

☐ 2. Connect air compressor to line.

☐ 3. Run air compressor until desired pressure has been reached.

Note: Do not pump against the meter, or you will damage it.

☐ 4. Check for a drop in pressure.

☐ 5. Ask your instructor to check your work.

☐ 6. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________

____

____

Water Valves and Faucets
Unit 1-F

Objective Sheet

Unit Objective

After completing this unit, the student should be able to install various types of faucets. The student should demonstrate these competencies by completing the job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to water valves and faucets with their definitions.
2. List five types of valves.
3. Match the parts of a globe valve with their locations.
4. Match the parts of a gate valve with their locations.
5. Match the parts of a check valve with their locations.
6. Match the parts of a ball valve with their locations.
7. Match the parts of a flush valve with their locations.
8. Distinguish between single and dual control faucets.
9. Select features of specific faucets.
10. Install a stop and waste valve (solder method). (Job Sheet 1)
11. Install a kitchen sink faucet. (Job Sheet 2)
12. Install a dual control lavatory faucet with pop-up drain plug. (Job Sheet 3)
13. Disassemble and reassemble a single lever kitchen sink faucet. (Job Sheet 4)

Water Valves and Faucets
Unit 1-F

Information Sheet

1. **Terms and definitions**

   a. **Diverter**—Bath and shower faucet used to change flow from tub filler to shower head or in the reverse direction

   b. **Escutcheon**—Decorative metal shield over valve body of faucets

   c. **Faucet**—Fixture used for drawing liquid from a pipe

   d. **Spread**—The distance between valve shanks on a sink faucet or a lavatory faucet

   Note: Spread is measured from the center of one inlet to the center of the other inlet.

   e. **Stop and waste valve**—Valve that has a drain plug on the discharge side and is used as a cut-off valve

   f. **Valve**—Mechanical device that regulates the flow of liquid in a pipe

2. **Types of valves**

   a. Globe

   b. Gate

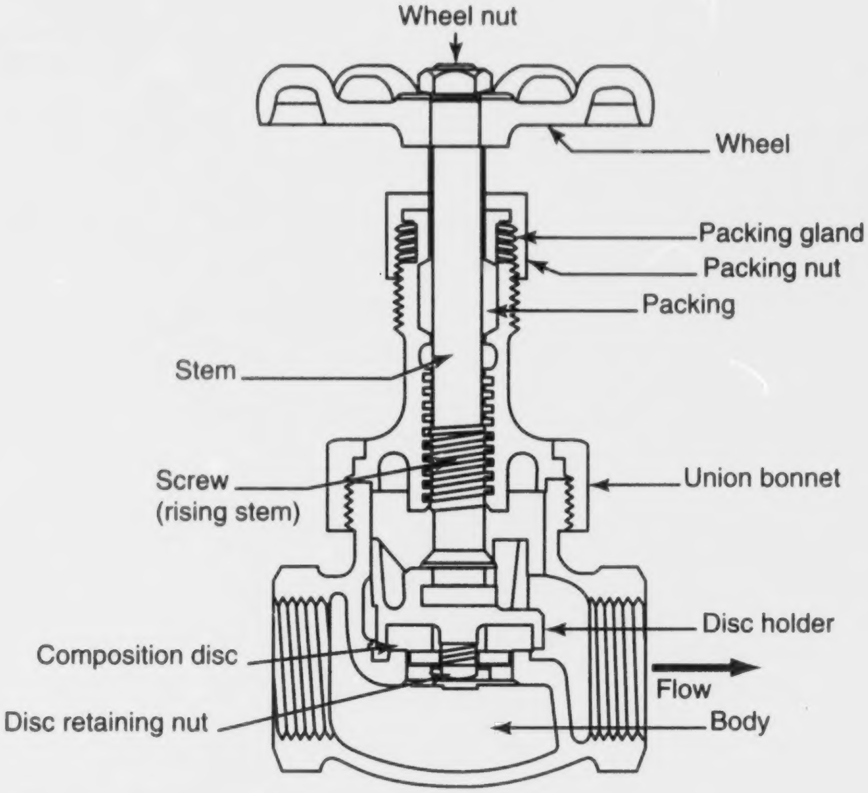
   c. Check

   d. Ball

   e. Flush

Information Sheet

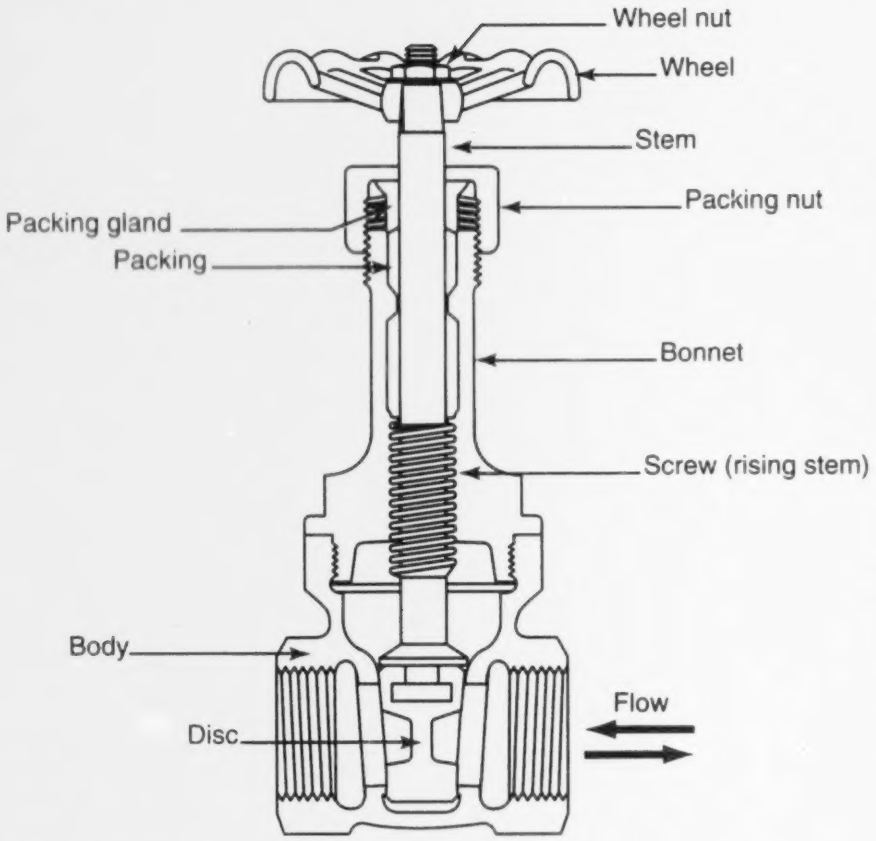
3. Parts of a globe valve



Courtesy of Stockham

Information Sheet

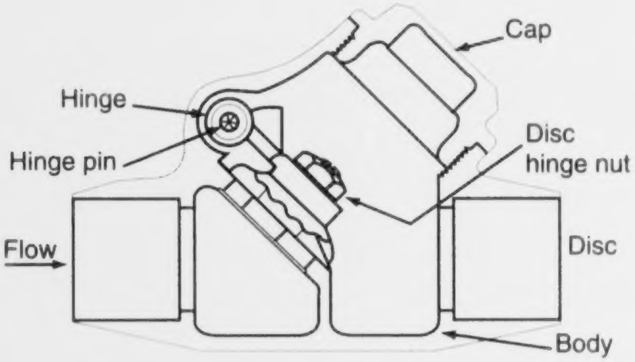
4. Parts of a gate valve



Courtesy of Stockham

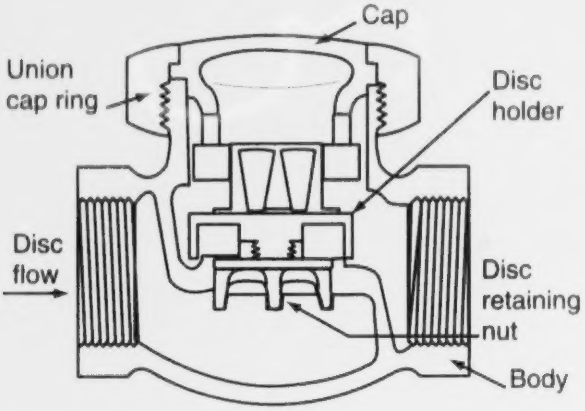
5. Parts of check valves

a. Swing check valve (screwed cap type "Y" pattern)



Courtesy of Stockham

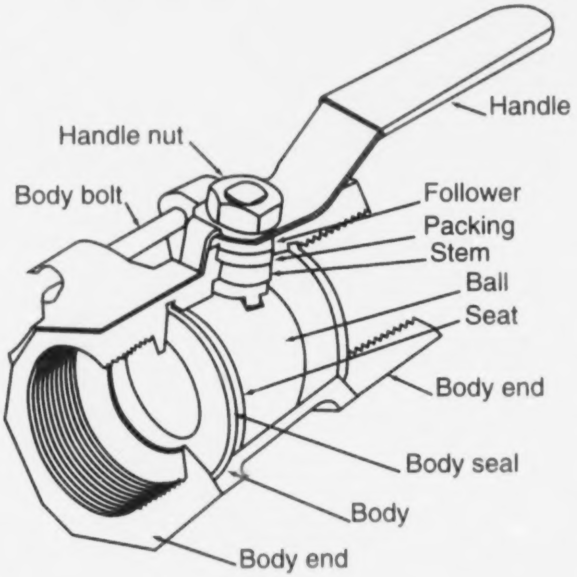
b. Lift check valve (union cap type)



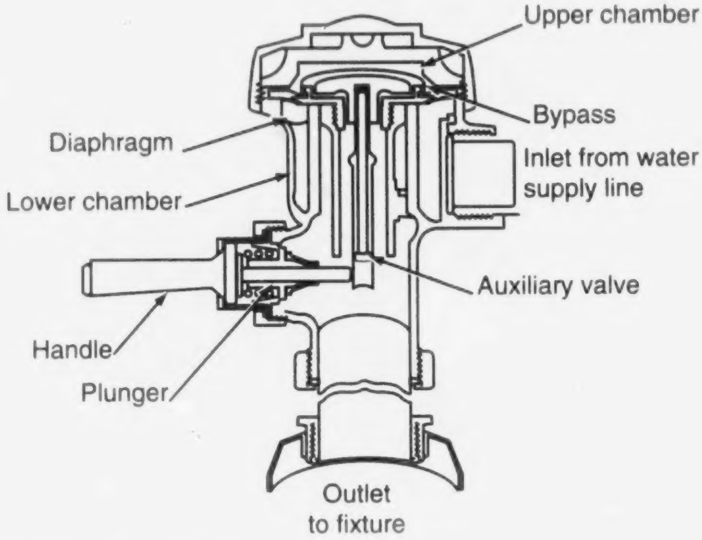
Courtesy of Stockham

Information Sheet

6. Parts of a ball valve



7. Parts of a flush valve



Courtesy of Sloan Valve Co.

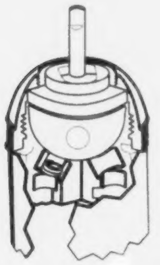
Information Sheet

8. Types of faucets

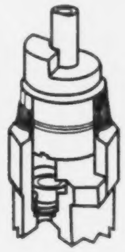
Note: Illustrations in this objective are courtesy of Delta Faucet Co.

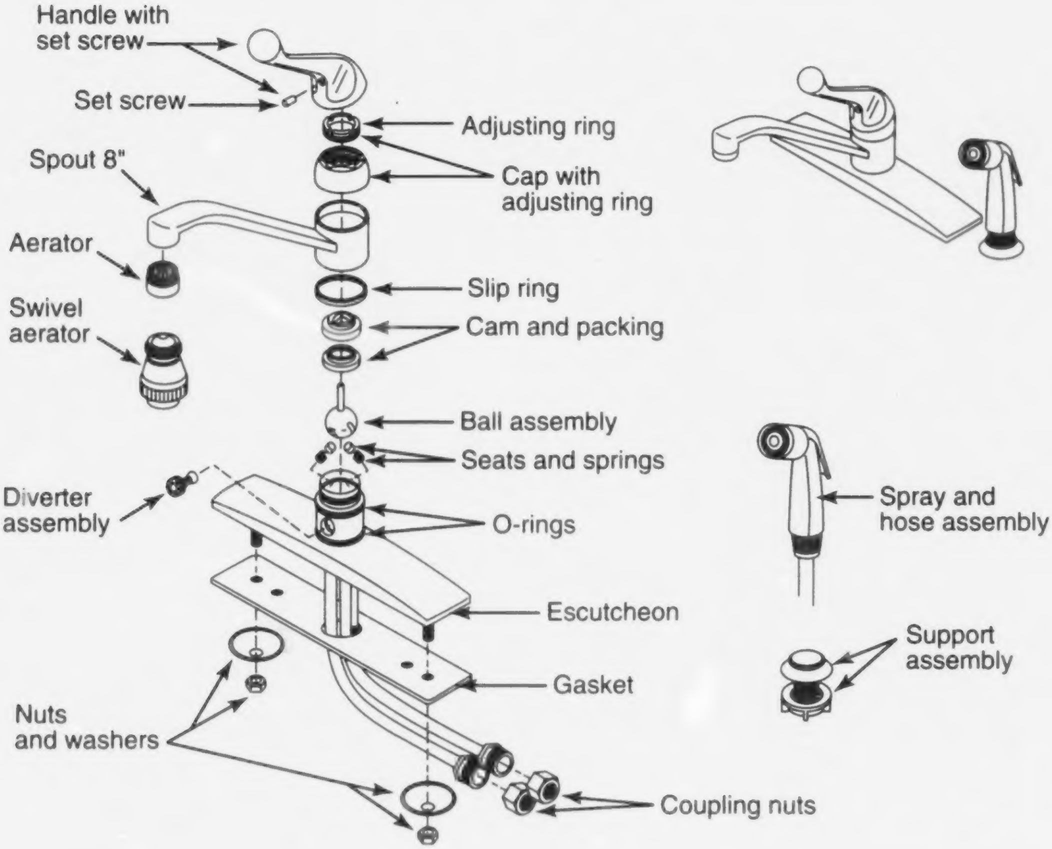
a. Single control

- Rotating ball valve



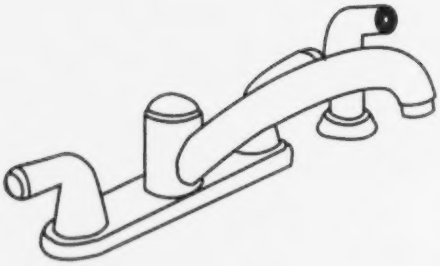
- Rotating cylinder valve





Information Sheet

b. Dual control



- Two compression valves
- Two noncompression valves

9. **Features of faucets**

a. Kitchen sink faucet

- Swing spout (deck or wall mount)
- Spray
- Hot and cold water valves
- Aerator
- Single and dual control valves
- Usually 8″ centers (dual control)

b. Lavatory faucet

- Stationary spout
- Hot and cold water valves
- Single and dual control valves
- Usually 4″ centers (dual control)
- Usually supplied with pop-up drain fitting

c. Bath and shower faucet

- Stationary spout
- Hot and cold water valves
- Single and dual control valves
- Shower head
- Usually 8″ centers (dual control)

Information Sheet

- Main body of valve and water piping installed during rough-in
- Diverter

d. Shower faucet

- Hot and cold water valves
- Single and dual control valves
- Shower head
- Usually 8″ centers (dual control)
- Main body of valve and water piping installed during rough-in

Water Valves and Faucets
Unit 1-F

Job Sheet 1—Install a Stop and Waste Valve (Solder Method)

Name ______________________________ Attempt Number ______________

Date ______________________________ Overall Rating ______________

Evaluation Criteria	**Rating**
• Connections do not leak	________
• Water flows through valve at normal rate	________
• Demonstrated proper safety precautions	________
• Used tools and equipment correctly	________
• Demonstrated quality of workmanship	________
• Completed task in a timely manner	________

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Stop and waste valve (brass)
- Short lengths of copper tubing
- Pipe vise
- Soldering tools
  - — Torch and tank outfit
  - — Striker
  - — Solder
  - — Flux
  - — Flux brush
  - — Clean cloth
  - — Sand cloth
  - — Fitting brush
  - — Safety glasses
- Combination slip-joint pliers

B. Procedure

Note: Put on safety glasses.

☐ 1. Gather all equipment and materials and carry to job site (work bench).

☐ 2. With sand cloth, clean one end of two pieces of copper tubing.

☐ 3. Place one piece of tubing in pipe vise (horizontal position).

☐ 4. Open valve.

Note: When opening a valve, completely open the valve and then turn it back a short turn. This will prevent sticking if left open for long periods of time.

Job Sheet 1

☐ 5. Remove waste (knurled) cap.

Caution: Do not lose washer that is inside cap.

☐ 6. Clean valve caps with fitting brush.

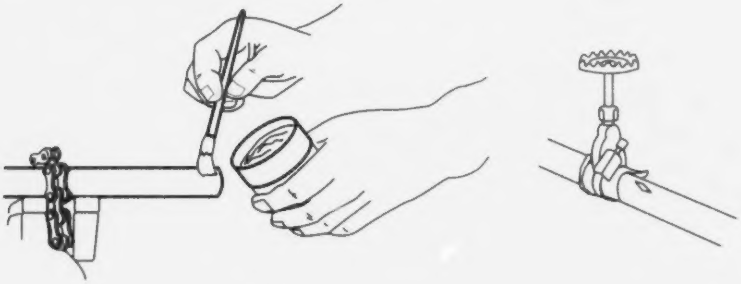
☐ 7. Apply flux to valve caps and to end of pipe in vise.

☐ 8. Determine direction of water flow and place valve on tube in vise.

Note: It is good practice to remove valve stem before soldering.

☐ 9. Apply flux to end of other tube and insert in outlet end of valve (Figure 1).

FIGURE 1



☐ 10. Set up and light the torch.

☐ 11. Solder the joints.

Note: Apply just enough heat and solder.

☐ 12. Wipe off excess solder.

☐ 13. Allow to cool before closing valve and replacing waste cap.

☐ 14. Ask your instructor to check your work.

☐ 15. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

____

____

Water Valves and Faucets
Unit 1-F

Job Sheet 2—Install a Kitchen Sink Faucet

Name ______________________ Attempt Number ______________

Date ______________________ Overall Rating ______________

Evaluation Criteria	Rating
• Installed faucet accurately	________
• Demonstrated proper safety precautions	________
• Used tools and equipment correctly	________
• Demonstrated quality of workmanship	________
• Completed task in a timely manner	________

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Dual control kitchen faucet
- Sink
- Basket strainer
- 3′ piece of 1/2″ copper tubing, type L
- Two 3/8″ speedy connectors
- Two 3/8″ compression x 1/2″ sweat adapters
- Two 1/2″ stop and waste valves
- Two 1/2″ 90° elbows
- Two 1/2″ 45° elbows
- Putty
- Spud wrench
- 12″ adjustable pliers
- Pipe tape and pipe compound
- Basin wrench
- Spanner wrench
- Strainer wrench
- Locknut wrench
- Tubing cutter (small or close)
- Fitting brush
- Soldering tools
    - — Torch and tank outfit
    - — Striker
    - — Solder
    - — Flux
    - — Flux brush
    - — Clean cloth
    - — Sand cloth
    - — Fitting brush
    - — Safety glasses

Job Sheet 2

B. Procedure

Note: Put on safety glasses.

☐ 1. Gather all equipment and materials and carry to job site.

☐ 2. Take the faucet out of the package and check for missing parts.

☐ 3. Remove sink from box and check for damage.

☐ 4. Cut 2 lengths (about 10″ each) of copper tubing.

☐ 5. Clean ends of tubing with sand cloth and apply flux.

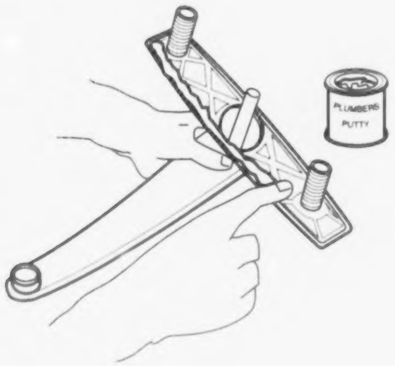
☐ 6. Clean male adapters with fitting brush and apply flux.

☐ 7. Light torch and solder adapters onto each 10″ pipe.

Note: Set these aside to cool.

☐ 8. Apply putty to base of faucet escutcheon (Figure 1).

FIGURE 1

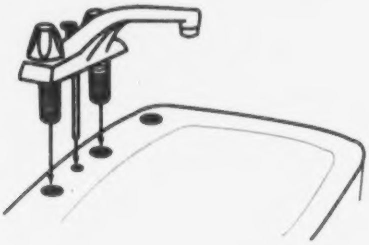


☐ 9. Place rubber washer on base of faucet.

Job Sheet 2

☐ 10. Insert faucet into sink holes (Figure 2).

FIGURE 2



☐ 11. Turn sink on edge.

☐ 12. Place metal washers and nuts on faucet shanks.

☐ 13. Pull the nuts tight with the spanner wrench.

Note: Check that the faucet is straight on the sink.

☐ 14. Install spray hose escutcheon in spray hole.

Note: Apply putty under escutcheon before installing.

☐ 15. Remove the spray nozzle from the hose.

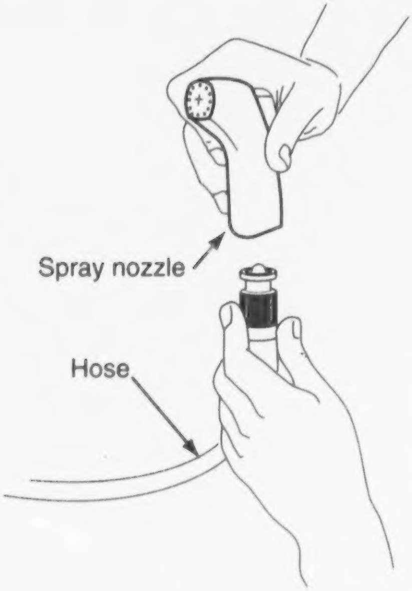
☐ 16. Connect hose to faucet body.

☐ 17. Push other end of hose through spray hole in sink.

Job Sheet 2

☐ 18. Connect spray nozzle (Figure 3).

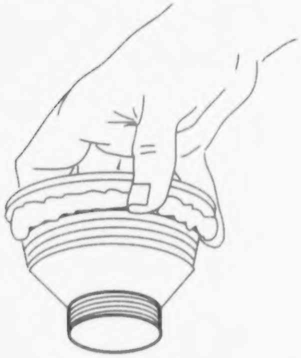
FIGURE 3



☐ 19. Remove basket strainer from box and disassemble.

☐ 20. Place putty on the underside of the basket strainer rim (Figure 4).

FIGURE 4



☐ 21. Place basket strainer in drain hole.

☐ 22. Stand sink on edge.

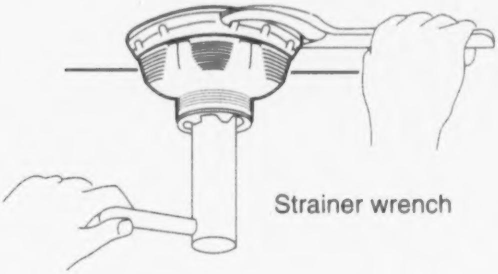
Job Sheet 2

☐ 23. Place fiber washer on underside of basket strainer followed by the large metal washer and nut.

Note: A little pipe dope helps pull the nut tight.

☐ 24. Pull the nut tight using strainer wrench and locknut wrench (Figure 5).

FIGURE 5



☐ 25. Apply pipe compound to $^1/_2$″ male adapters.

☐ 26. Install on valve shanks.

Note: Some faucets are made to receive both male or female adapters.

☐ 27. Install the sink into the counter top.

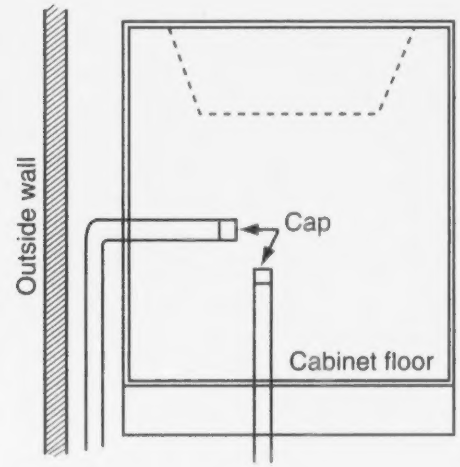
Note: Check with instructor about the various rims and installation methods.

Job Sheet 2

☐ 28. Cut the test cap off the 1/2″ copper tube risers using a small tubing cutter or a close tubing cutter (Figure 6).

Note: 1/2″ copper tubing should extend vertically through sink cabinet floor or horizontally through the back wall of cabinet.

FIGURE 6



☐ 29. Clean riser ends and drops from faucet with sand cloth.

Note: Install escutcheons before connecting tubing.

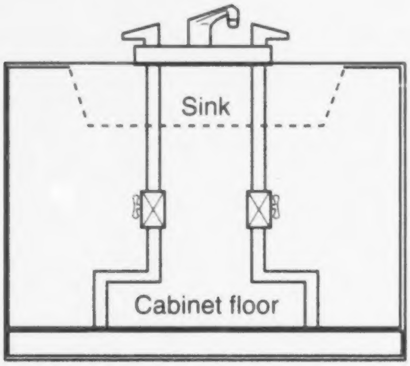
☐ 30. Clean fittings and valves with fitting brush.

☐ 31. Flux tubing ends, fittings, and valves.

Job Sheet 2

☐ 32. Place valves on drop ends and connect valves to risers using 90° and 45° elbows if necessary (Figure 7).

FIGURE 7



☐ 33. Solder fittings.

☐ 34. Wipe clean.

☐ 35. Remove spout aerator.

☐ 36. Turn on water to flush system.

☐ 37. Shut off water.

☐ 38. Replace aerator.

☐ 39. Ask your instructor to check your work.

☐ 40. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Water Valves and Faucets
Unit 1-F

Job Sheet 3—Install a Dual Control Lavatory Faucet With Pop-Up Drain Plug

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Installed faucet accurately	______
• Demonstrated proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Lavatory faucet with pop-up drain
- Lavatory
- Putty
- 8″ adjustable wrench
- Spanner wrench
- 10″ adjustable pliers
- Pipe dope
- Plug wrench
- Spud wrench
- Clean wiping cloth
- Cloth or plastic for floor protection

B. Procedure

Note: Put on safety glasses.

☐ 1. Gather all equipment and materials and carry to job site.

Note: Provide floor protection.

☐ 2. Remove faucet and drain from box and check for missing parts.

☐ 3. Remove lavatory from carton and check for damage.

☐ 4. Remove shank nuts, washers, and gasket.

☐ 5. Place putty under faucet escutcheon.

☐ 6. Replace rubber or plastic gasket.

Job Sheet 3

☐ 7. Insert faucet valve shanks through lavatory holes.

☐ 8. Press down lightly.

☐ 9. Place metal washers and locknuts on shanks.

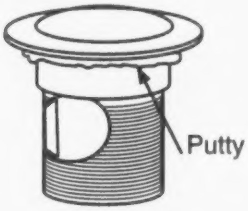
☐ 10. Pull tight with spanner wrench.

Note: Be sure that the faucet is straight on the lavatory.

☐ 11. Disassemble drain plug.

☐ 12. Place a bead of putty under drain lip (Figure 1).

FIGURE 1



☐ 13. Place drain plug in sink outlet.

Caution: China lavatories can break easily; use care when installing drains and faucets.

☐ 14. Slip rubber gasket onto the lower end of drain plug.

☐ 15. Place the metal washer and nut behind the rubber gasket.

☐ 16. Pull tightly with the spud wrench.

Note: Hold the drain plug in place with a plug wrench.

☐ 17. Screw the drain body onto the drain plug.

Note: The drain body side-outlet must face the rear of the lavatory.

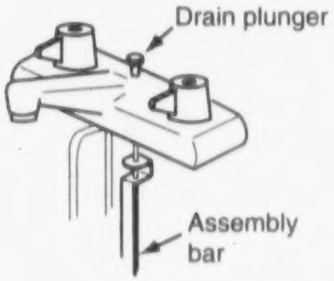
☐ 18. Screw the tail piece into the drain body.

☐ 19. Insert the drain plunger through the faucet body.

Job Sheet 3

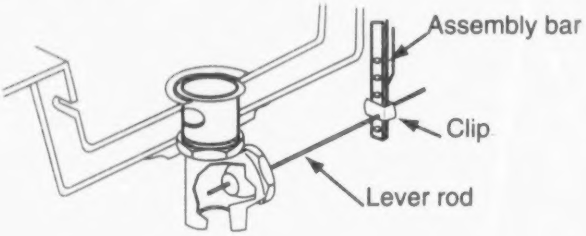
☐ 20. Connect to the lever assembly bar (Figure 2).

FIGURE 2



☐ 21. Secure lever rod in assembly bar using lever rod clip (Figure 3).

FIGURE 3



☐ 22. Insert rod into drain body.

☐ 23. Tighten rod nut.

☐ 24. Slip assembly bar up onto the drain plunger.

Note: Do not tighten lock screw.

☐ 25. Determine approximate location of rod-bar connection and make the connection.

☐ 26. Tighten lock screw on assembly bar.

☐ 27. Check pop-up drain for correct action.

Note: Lift drain plunger up and down.

☐ 28. Pull lever rod all the way down.

☐ 29. Loosen assembly bar lock screw.

☐ 30. Raise drain plunger about $^1/_8$″.

Job Sheet 3

☐ 31. Tighten lock screw.

Note: The drain plunger handle should not touch the faucet body when pressed.

☐ 32. Install the lavatory.

Note: See Unit 3-F, "Fixtures and Appliances."

☐ 33. Ask your instructor to check your work.

☐ 34. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ____________________

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Water Valves and Faucets
Unit 1-F

Job Sheet 4—Disassemble and Reassemble a Single Lever Kitchen Sink Faucet

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	Rating
• Handled delicate parts of faucet carefully	______
• Handled chrome plated parts of faucet carefully	______
• Disassembled and assembled faucet accurately	______
• Demonstrated proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

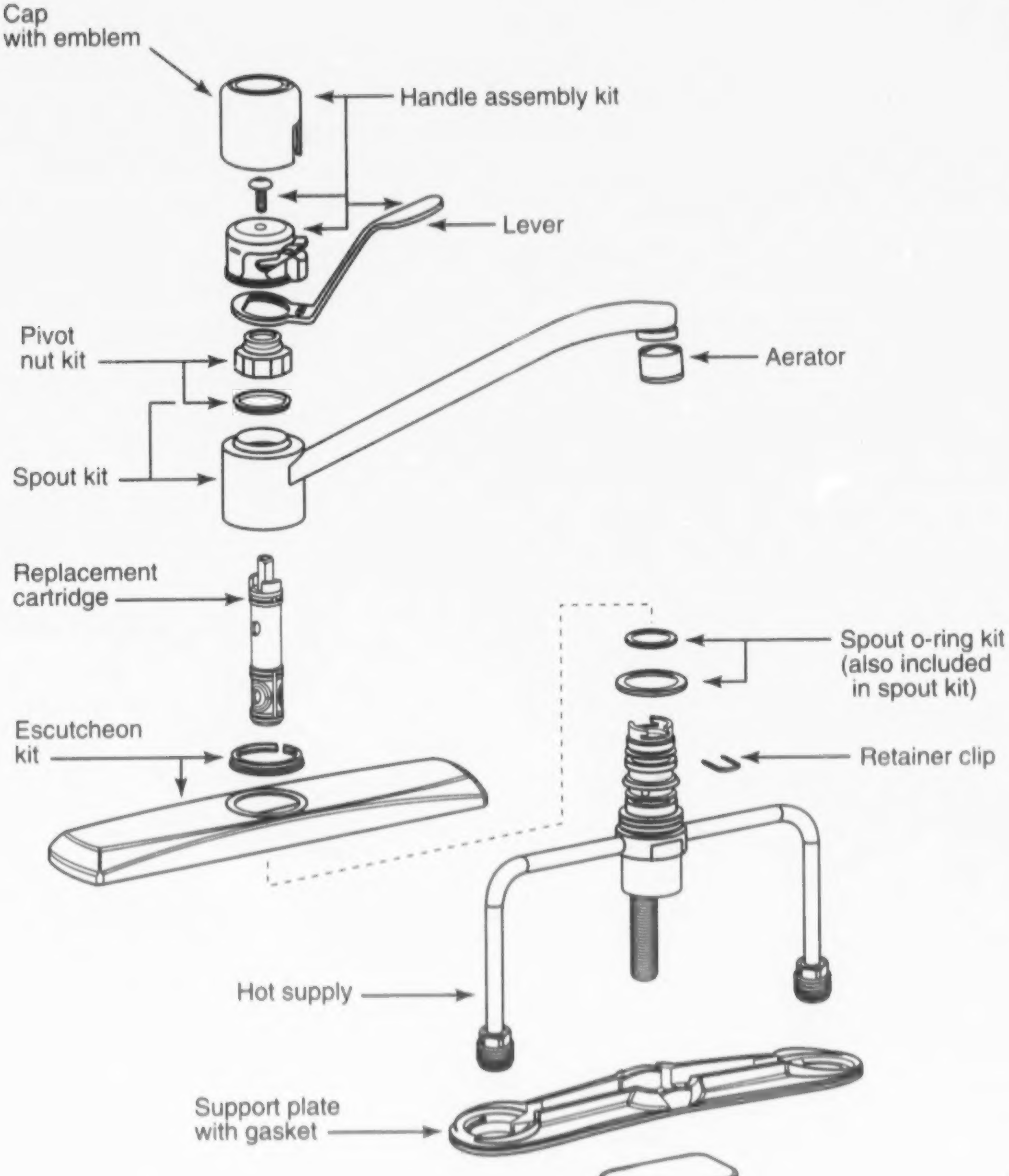
A. Equipment and materials

- Single lever kitchen sink faucet
- Phillips head screwdrivers
- Straight head screwdrivers
- Combination pliers
- 8″ adjustable wrench
- Wiping cloth

B. Procedure (Figure 1)

Note: The following procedure is based on the Moen single-handle kitchen faucet illustrated on the next page. Ask your instructor to provide you with the manufacturer's specifications and installation procedures for the single lever kitchen sink faucet you will be using to complete this job sheet.

Job Sheet 4



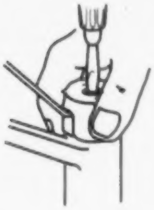
Illustrations in this job sheet are used with permission of Moen Incorporated, North Olmsted, Ohio.

Job Sheet 4

☐ 1. Disassemble

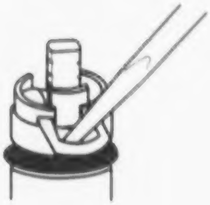
- Turn off both hot and cold water supplies.
- Pull handle cap up and off.
- Remove the handle screw.
- Lift and tilt handle lever and handle body off (Figure 2).

FIGURE 2



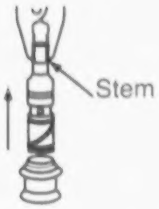
- Remove retainer nut and lift off grooved sleeve.
- Lift and twist off spout.
- Pry out retainer clip with screwdriver (Figure 3).

FIGURE 3



- Grasp cartridge stem with pliers and lift out cartridge (Figure 4).

FIGURE 4



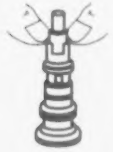
- Flush supply lines by slowly turning on the hot and cold water supplies.

Job Sheet 4

☐ 2. Reassemble

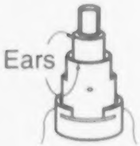
- With cartridge stem up, insert and push down cartridge by its ears (Figure 5).

FIGURE 5



- Turn cartridge ears to front and back as shown (Figure 6).

FIGURE 6



- Turn red (notched) flat of cartridge stem toward sink.
- Replace clip all the way.
- Replace spout.

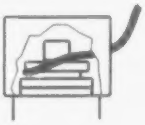
Note: Push down until it nearly touches the faucet escutcheon.

- Place grooved sleeve on top of body and screw on retainer nut.

Note: Tighten snugly but be careful not to cross thread.

- Press cartridge stem down.
- Holding handle up, hook ring in handle housing into groove on sleeve (Figure 7).

FIGURE 7



- Swing handle back and forth until it drops into place.

Job Sheet 4

- Replace handle screw and tighten securely.
- Push handle cap down until it snaps into place.

☐ 3. Ask your instructor to check your work.

☐ 4. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Drainage Connections
Unit 2-F

Objective Sheet

Unit Objective

After completing this unit, the student should be able to install various drainage connections. The student should demonstrate these competencies by completing the job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to drainage connections with their definitions.
2. Identify various types of drainage connections used in residential plumbing.
3. List ways a trap can lose its seal.
4. Install a cast iron water closet flange. (Job Sheet 1)
5. Install a plastic water closet flange. (Job Sheet 2)
6. Install a brass to copper pipe water closet flange. (Job Sheet 3)
7. Install a brass to lead pipe water closet flange. (Job Sheet 4)
8. Install a lavatory trap. (Job Sheet 5)
9. Install a kitchen sink trap. (Job Sheet 6)

Drainage Connections
Unit 2-F

Information Sheet

1. **Terms and definitions**

   a. **Basket strainer**—A recessed strainer fitting into the drain outlet of a sink

   b. **Capillary attraction**—Movement of liquid upward through cellular structure of fibrous strands or through structure of other solids

   c. **Evaporation**—Loss of water (especially in a drainage trap) to the atmosphere

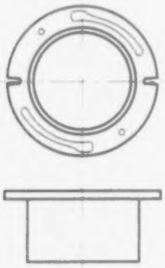
   d. **O-ring**—Rubber seal used around stems of some valves to prevent water from leaking out

   e. **Plumber's putty**—A soft prepared mixture used to seal sink rims, drain outlets, and other places where a sealant is needed

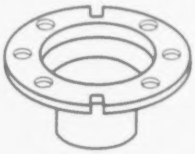
   f. **Seal of a trap**—Depth of water held in a trap under normal operating conditions

2. **Types of drainage connections**

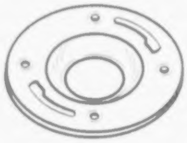
   a. Water closet flanges



- Cast iron

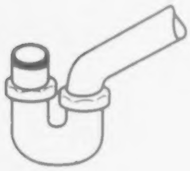


- PVC



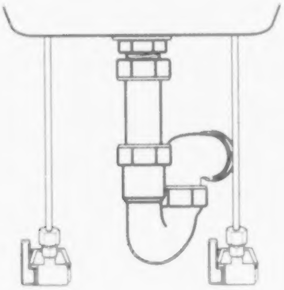
- Brass

   b. Lavatory P trap

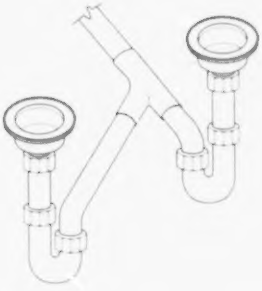


Information Sheet

c. Kitchen sink traps and wastes

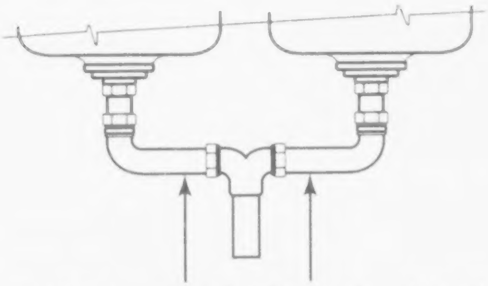


- Single sink/vanity



- Single waste—2 traps

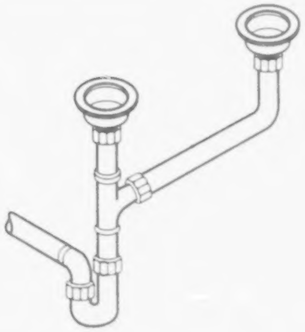
- Double well continuous waste



1 1/2" sink waste slip joint 2-part center outlet

Note: Specify distance between sink outlets.

— Center outlet



— End outlet

Information Sheet

3. Loss of trap seals

a. Evaporation

Note: This is usually due to the fixture not being used for long periods of time.

b. Capillary attraction

Note: This is usually due to string or other substances caught in the trap.

c. Siphonage

Note: This is usually due to improper arrangement of trap and waste piping, causing high velocity of drain water.

d. Leak

Note: This is usually due to a cracked trap or loose or decayed cleanout washer.

e. Back pressure

Note: This is usually due to poor venting of fixtures.

Drainage Connections
Unit 2-F

Job Sheet 1—Install a Cast Iron Water Closet Flange

Name ______________________ Attempt Number ______________

Date ______________________ Overall Rating ______________

Evaluation Criteria	**Rating**
• Installed flange correctly	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Cast iron water closet flange
- Stub of 4″ cast iron pipe
  Note: Secure pipe in position to receive flange. Top of pipe should be even with or slightly below finished floor level.
- Caulking tools and equipment
  - — Furnace and propane tank
  - — Yarning iron
  - — Packing iron
  - — Flooring chisel
  - — Lead pot
  - — Ladle
  - — Oakum
  - — Lead
  - — Hammer
- Clean cloth
- Hammer
- Safety glasses

B. Procedure

☐ 1. Gather all equipment and materials and carry to the job site.

Note: Instructor should emphasize safety precautions while working with lead.

☐ 2. Set up the propane tank and furnace in a safe place near the job.

☐ 3. Put on safety glasses.

☐ 4. Place lead pot on furnace and light furnace.

Note: Cut up manageable pieces of lead with flooring chisel and place in lead pot.

Job Sheet 1

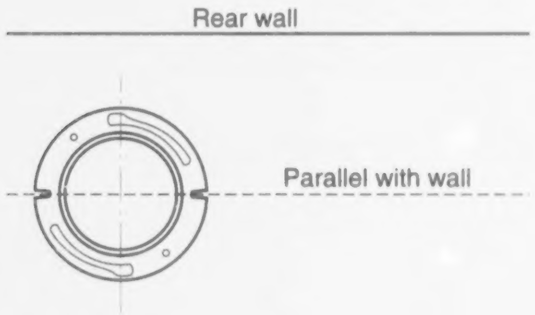
☐ 5. Cut several strands of oakum into workable lengths, 27″–30″.

☐ 6. Clean floor around water closet drain pipe.

☐ 7. Place water closet flange on pipe and line up holes (Figure 1).

Note: Flanges are available in various depths.

FIGURE 1



☐ 8. Place the ladle on the furnace to warm up.

☐ 9. Yarn the oakum into the fitting and tighten with the packing iron.

☐ 10. Pour lead, in one pour, into fitting.

Caution: Fitting and oakum must be dry to avoid steam explosion.

☐ 11. Return extra lead to pot and shut off furnace.

☐ 12. Caulk lead into the fitting, using inside and outside irons.

Note: Throughout the whole process, keep the flange in line.

☐ 13. Install the water closet.

Note: Refer to Unit 3-F, "Fixtures and Appliances" for installation.

☐ 14. Ask your instructor to check your work.

Job Sheet 1

☐ 15. Clean tools and work area and return all equipment and materials to their proper places.

Caution: Use care in handling hot furnace and lead pot.

Evaluator's Comments: ______________________________

Drainage Connections
Unit 2-F

Job Sheet 2—Install a Plastic Water Closet Flange

Name ____________________ Attempt Number ____________

Date ____________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Installed flange correctly	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Plastic closet flange
- Available stub of 3″ plastic PVC
  Note: Stub should be roughed in at the correct height to take the adapter.
- PVC cleaner with brush
- PVC solvent cement with brush
- 6′ rule
- Medium size screwdriver
- Four #8—1 1/2″ wood screws
- Hand drilling machine and 1/8″ drill

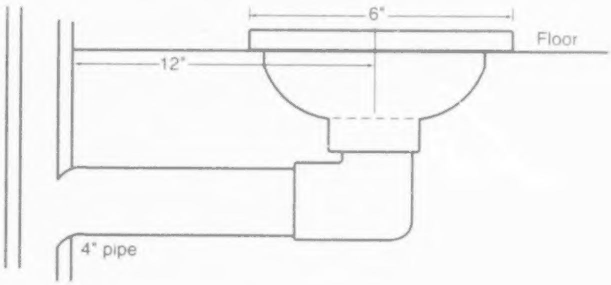
B. Procedure

☐ 1. Gather all equipment and materials and carry to the job site.

☐ 2. Measure closet flange to be sure it will fit flush on the finished floor (Figure 1).

Note: Holes should be cut to allow flange to be secured to floor with screws.

FIGURE 1



Job Sheet 2

☐ 3. Clean pipe and flange with the cleaner.

Note: Clean only those parts to be cemented.

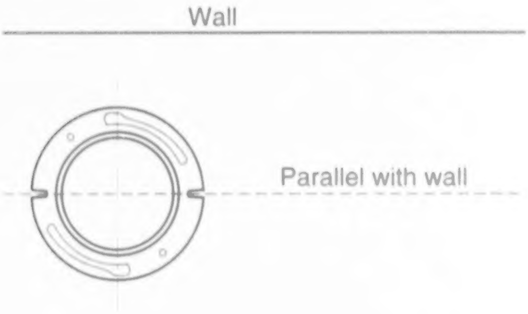
☐ 4. Apply cement to pipe and closet flange.

Note: Steps 4 and 5 must be done quickly because the cement hardens in a few seconds.

☐ 5. Push the flange into the pipe and twist to line up closet bolt holes (Figure 2).

Note: Make sure flange rests on the floor.

FIGURE 2



☐ 6. Drill holes into floor and screw flange to floor.

☐ 7. Ask your instructor to check your work.

☐ 8. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ____________________

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____

Drainage Connections
Unit 2-F

Job Sheet 3—Install a Brass to Copper Pipe Water Closet Flange

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Installed flange correctly	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Brass closet flange
- Torch and tank outfit
- Striker
- Solder
- Flux with brush
- Sand cloth
- Clean cloth
- Four #8—1 1/2″ wood screws
- Hand drilling machine and 1/8″ drill
- Medium screwdriver
- Round file
- Fire extinguisher
- Safety glasses

B. Procedure

Note: Wear safety glasses for soldering jobs.

☐ 1. Gather all equipment and materials and carry to the job site.

☐ 2. Clean the pipe and flange with sand cloth.

Note: Clean only those parts to be soldered.

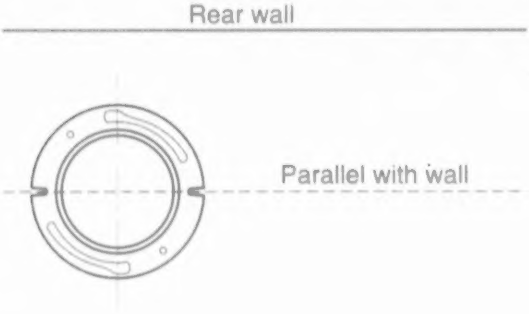
☐ 3. Apply flux to parts to be soldered.

Note: Copper drain pipe should have been roughed in to provide correct height of pipe.

Job Sheet 3

☐ 4. Place flange on pipe and line up the closet bolt holes (Figure 1).

FIGURE 1



☐ 5. Put on safety glasses.

☐ 6. Drill holes into floor and screw flange to floor.

☐ 7. Light and adjust the torch.

☐ 8. Apply heat, and solder the flange and pipe from the inside.

☐ 9. With a round file, remove any burrs on the pipe.

☐ 10. Ask your instructor to check your work.

☐ 11. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ____

____

____

Drainage Connections
Unit 2-F

Job Sheet 4—Install a Brass to Lead Pipe Water Closet Flange

Name ____________________ Attempt Number ____________

Date ____________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Installed flange correctly	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Brass closet flange
- Torch and tank outfit
- Striker
- Solder
- Flux and brush
- Sand cloth
- Clean cloth
- Four #8—1 1/2″ wood screws
- Hand drilling machine and 1/8″ drill
- Medium screwdriver
- Round file
- Ball peen hammer
- Hacksaw
- Tin snips
- Pocket knife
- Safety glasses
- Fire extinguisher

B. Procedure

Note: Wear safety glasses for soldering jobs.

☐ 1. Gather all equipment and materials and carry to the job site.

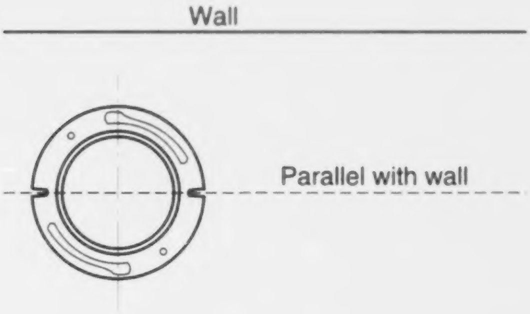
☐ 2. Clean the pipe flange with sand cloth.

Note: Clean only that part to be soldered.

Job Sheet 4

☐ 3. Place flange over pipe and line up the closet bolt holes (Figure 1).

FIGURE 1



☐ 4. Drill holes through screw holes into floor.

☐ 5. Screw flange to floor using screwdriver and wood screws.

☐ 6. Using a hacksaw, cut off the lead pipe, just above the floor.

☐ 7. With the ball peen hammer, peen lead pipe over to meet the brass flange.

Note: If necessary, trim the lead pipe with the tin snips.

☐ 8. Clean the edge of the lead pipe with a pocket knife or scraper to prepare the surface for soldering.

Note: The edge of the lead pipe should line up with the ring of the flange to be soldered.

☐ 9. Apply flux to the flange and lead pipe.

Note: Apply only to that portion to be soldered.

☐ 10. Solder the connection, being careful to apply the flame only to the brass flange and not to the lead pipe.

Caution: This job is a potential fire hazard, so keep fire extinguisher handy.

☐ 11. Wipe the soldered connection to remove excess flux; if necessary, smooth the edge of the lead pipe.

☐ 12. Ask your instructor to check your work.

Job Sheet 4

☐ 13. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

Drainage Connections
Unit 2-F

Job Sheet 5—Install a Lavatory Trap

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Installed trap correctly	______
• Trap did not leak when tested	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- 1 1/2″ chromed brass P trap with deep escutcheon
- Lavatory, hung on wall with faucet and pop-up drain installed
- 1 1/2″ x 1 1/4″ slip nut with washer
- 6′ rule or steel tape
- 2″ tubing cutters
- Spud wrench or all purpose wrench
- Pipe compound
- 1 1/2″ PVC straight male adapter

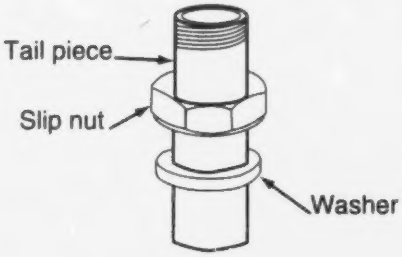
B. Procedure

☐ 1. Gather all equipment and materials and carry to the job site.

☐ 2. Open trap carton and inspect for missing parts.

☐ 3. Place 1 1/2″ x 1 1/4″ slip nut and washer on lavatory drain tail piece (Figure 1).

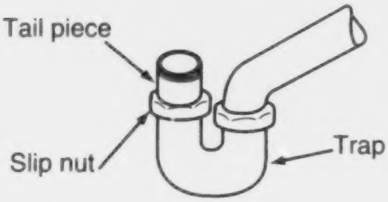
FIGURE 1



Job Sheet 5

☐ 4. Place a small amount of pipe compound on the "J" bend threads and attach "J" bend to tail piece slip nut (Figure 2).

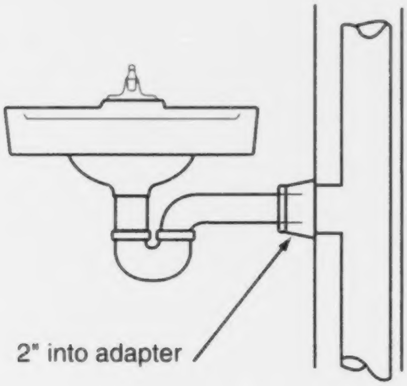
FIGURE 2



☐ 5. Cut off PVC drain pipe close to wall and cement on the male adapter.

☐ 6. Measure the distance from the "J" bend to the PVC adapter and cut the trap discharge tube 2" longer than that measurement (Figure 3).

FIGURE 3

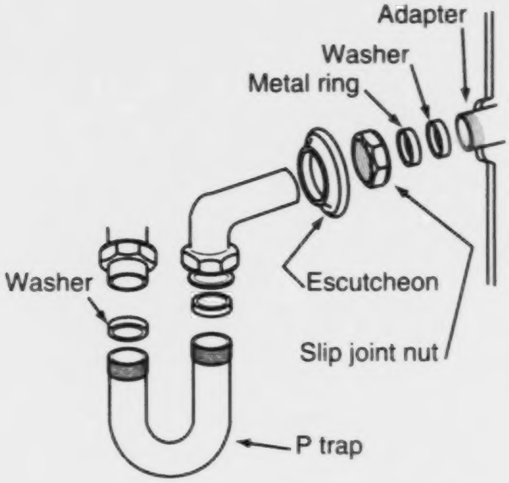


Job Sheet 5

☐ 7. Apply pipe compound to PVC adapter and make final connections (Figure 4).

Note: Make sure escutcheon, slip nuts, and washers are in proper order. Check local codes.

FIGURE 4



☐ 8. Ask your instructor to check your work.

☐ 9. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

____

____

Drainage Connections
Unit 2-F

Job Sheet 6—Install a Kitchen Sink Trap

Name ____________________ Attempt Number __________

Date ____________________ Overall Rating __________

Evaluation Criteria	Rating
• Installed trap correctly	______
• Trap did not leak when tested	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- $1^1/_2$″ tubular P trap
- Kitchen sink, installed in counter, with faucet and basket strainer
- Two $1^1/_2$″ tailpieces
  Note: Length is to be determined by instructor.
- 2″ tubing cutters
- Spud wrench or all purpose wrench
- Pipe dope

B. Procedure

☐ 1. Gather all equipment and materials and carry to the job site.

☐ 2. Take the continuous waste out of the carton and inspect for missing parts.

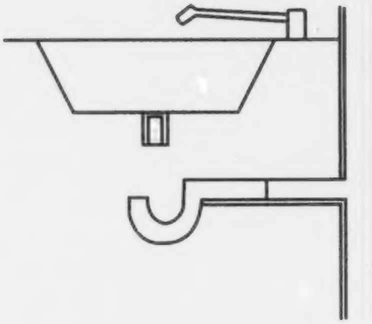
☐ 3. Place washers on top of flanges and connect tail pieces to basket strainers.

Note: Slip nuts should be provided on the strainers.

Job Sheet 6

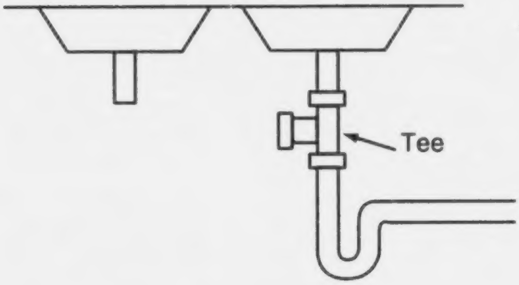
☐ 4. Assemble trap, hand tight, and insert in waste pipe drain (Figure 1).

FIGURE 1



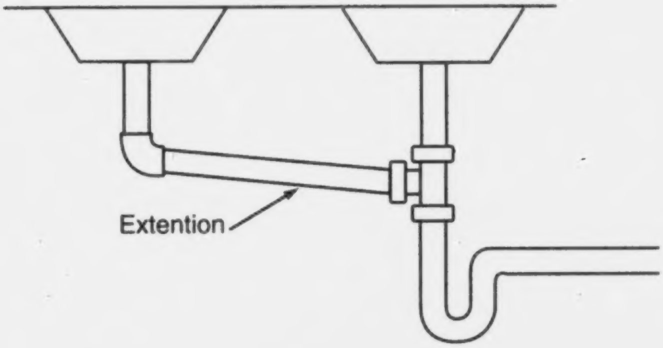
☐ 5. Connect continuous waste tee, hand tight to tail piece nearest the trap (Figure 2).

FIGURE 2



☐ 6. Connect continuous waste extension, hand tight to the other tail piece (Figure 3).

FIGURE 3

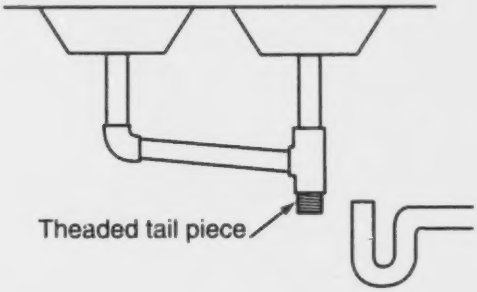


☐ 7. Mark extension piece to fit tee socket and cut with tubing cutters.

Job Sheet 6

☐ 8. Place a small amount of pipe dope on continuous waste tail piece and screw into bottom of tee (Figure 4).

FIGURE 4



☐ 9. Swing trap around to connect tail piece, but do not connect at this point.

Note: Measure length of tail piece needed to make trap connection. Sink tail pieces may need to be shortened.

☐ 10. Cut trap to correct length.

Note: Line up cutter on tube carefully or the cutting wheel will "track" out spiral grooves.

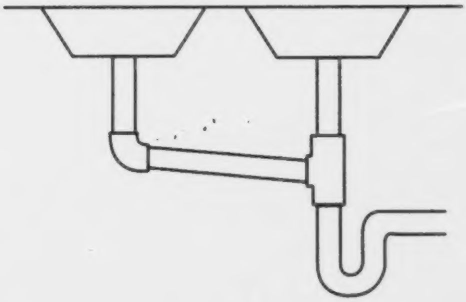
☐ 11. Remove trap and continuous waste and disassemble.

☐ 12. Apply a small amount of pipe dope to all threaded parts and reassemble.

☐ 13. Place continuous waste on sink tail pieces and connect using slip nuts and washers.

☐ 14. Connect trap to continuous waste tail piece (Figure 5).

FIGURE 5



☐ 15. Connect trap to waste pipe drain.

Job Sheet 6

☐ 16. Ask your instructor to check your work.

☐ 17. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ____

____

____

Fixtures and Appliances
Unit 3-F

Objective Sheet

Unit Objective

After completing this unit, the student should be able to install various types of fixtures and appliances. The student should demonstrate these competencies by completing the job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to fixtures and appliances with their definitions.
2. Identify common fixtures and appliances used in residential plumbing.
3. Match fixtures and appliances with the correct installation requirements.
4. Select true statements concerning the construction and materials used in the manufacture of fixtures and appliances.
5. Install a floor-mounted water closet. (Job Sheet 1)
6. Install a wall-mounted lavatory. (Job Sheet 2)
7. Install a recessed bathtub. (Job Sheet 3)
8. Install shower bath accessories in a ceramic tile bathroom. (Job Sheet 4)
9. Install an electric water heater. (Job Sheet 5)
10. Install a dishwasher. (Job Sheet 6)
11. Install a garbage disposal unit. (Job Sheet 7)
12. Install a gas water heater. (Job Sheet 8)

Fixtures and Appliances
Unit 3-F

Information Sheet

1. **Terms and definitions**

    a. **Backing**—Wood or other support placed in the building walls to which plumbing fixtures can be attached

    b. **Bathtub**—Water receptacle shaped to accommodate the entire body for bathing

    c. **Bidet**—A low set bowl equipped with hot and cold running water that is used especially for bathing the internal and external genitals and posterior parts of the body

    d. **Dishwasher**—An electric appliance for washing dishes

    e. **Drainage fixture unit (DFU)**—A common measure of the probable discharge into the drainage system by various types of plumbing fixtures on the basis of one DFU being equal to 7.5 gallons per minute of discharge

        Note: The drainage fixture unit value for a particular fixture depends on its volume rate of drainage discharge, on the duration of a single drainage operation, and on the average time between operations.

    f. **Fixture branch**—A water supply pipe between the fixture supply pipe and a water distribution pipe

    g. **Fixture drain**—The drain line from the trap of a fixture to the junction of that drain with any other pipe

    h. **Fixture supply**—A water supply pipe connecting the fixture with the fixture branch pipe

    i. **Flood level rim**—The top edge of a plumbing fixture or receptacle from which the water overflows

    j. **Flush**—To wash out with a large amount of water

    k. **Full bath**—A bathroom containing a water closet, lavatory, and bathtub

    l. **Garbage disposal**—An electric grinding device used with water to grind food wastes and discharge them into the drainage system

    m. **Half-bath**—A bathroom containing a water closet and lavatory

    n. **Kitchen sink**—A shallow flat-bottom fixture used in the kitchen for cleaning dishes and in the preparation of certain foods

    o. **Laundry tray**—A fixed tub installed in a laundry room of a home; supplied with cold and hot water and a drain connection and used for washing clothes and other household items

    p. **Lavatory**—A fixture designed for washing the hands and face; commonly found in bathrooms and rest rooms

Information Sheet

q. **Plumbing appliance**—A special class of plumbing fixture intended to perform a special function

r. **Plumbing fixture**—A receptacle for wastes that are ultimately discharged into the drainage system

s. **Three-quarter bath**—A bathroom containing a water closet, lavatory, and a shower bath

t. **Vanity**—A bathroom fixture consisting of a lavatory set into or onto the top of a cupboard or cabinet

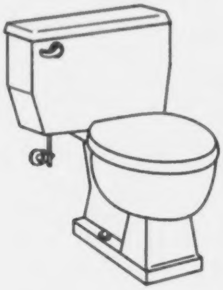
u. **Wall-hung**—Refers to a plumbing fixture that is supported from a wall

v. **Water closet (toilet)**—A water-flushed plumbing fixture designed to receive human excrement directly from the user of the fixture

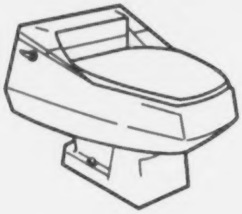
Note: The water closet is commonly referred to as a toilet.

2. **Fixtures and appliances in residential plumbing**

a. **Water closets (toilets)**

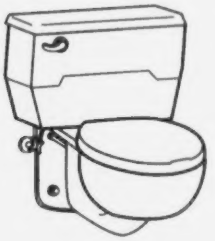


- Floor-set with close-coupled tank and bowl



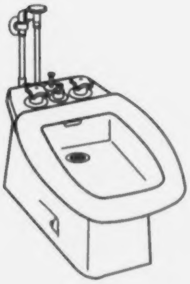
- One-piece floor-set tank and bowl combination

Information Sheet

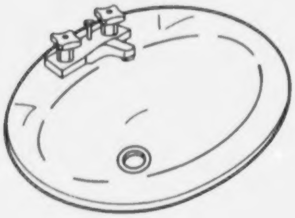


- Wall-hung siphon jet with close-coupled tank and bowl

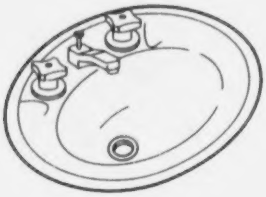
b. **Bidet**



c. **Lavatories**

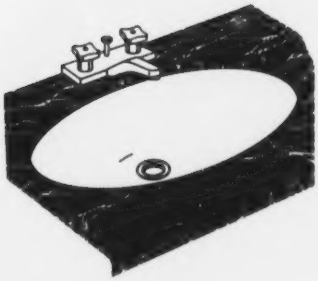


- Self-rimming vanity lavatory

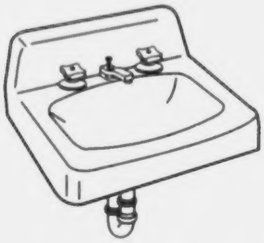


- Rim-type vanity lavatory

Information Sheet

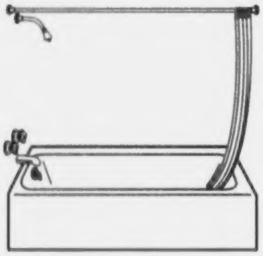


- Under-counter vanity lavatory

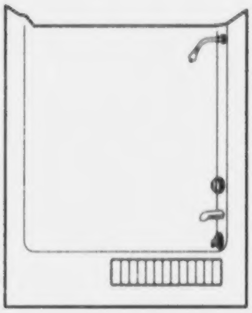


- Wall-hung lavatory

d. **Baths**



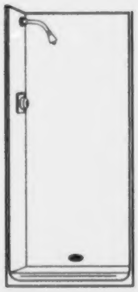
- Recessed bathtub



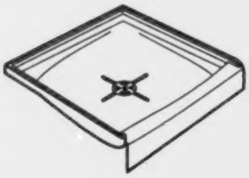
- Bath-shower module

Information Sheet

e. **Shower baths**



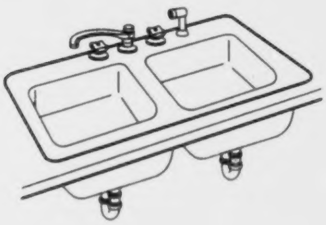
- Shower enclosure



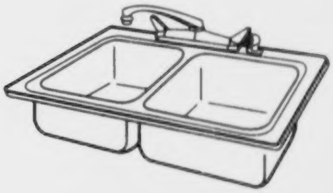
- Shower base

Note: Walls are built-in using a variety of materials.

f. **Kitchen sinks**



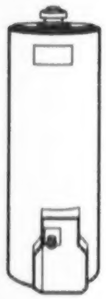
- Self-rimming



- Rim-type

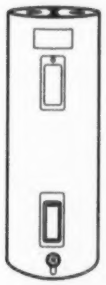
Information Sheet

g. **Water heaters**



Courtesy of A.O. Smith

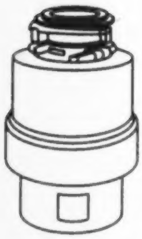
- Gas



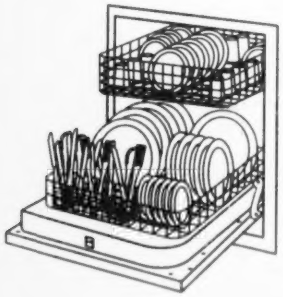
Courtesy of A.O. Smith

- Electric

h. **Garbage disposal**



i. **Dishwasher**



Information Sheet

j. **Laundry trays**

- Floor model

- Wall-hung model

3. Installation requirements for fixtures and appliances

Note: Refer to local codes.

a. Water closet

- Rated at 6 DFU
- Requires a minimum of 3″ for drain pipe
- Requires a minimum of 2″ for vent pipe
- Has trap as an integral part of the fixture

  Note: The trap is built into the water closet and needs no external additions.

- Has a built-in flushing device

  Note: The built-in flushing device needs no external water fitting.

b. Bidet

- Rated at 2 DFU
- Requires a minimum of 1 1/2″ for drain pipe
- Requires a minimum of 1 1/4″ for vent pipe
- Requires a trap connection to the waste pipe
- Requires a water fitting to deliver water to the nozzle
- Has vacuum breaker on water supply

Information Sheet

c. Lavatory

- Rated at 1 DFU
- Requires a minimum of 1 1/4″ for drain pipe
- Requires a minimum of 1 1/4″ for vent pipe
- Requires a trap connection to the waste pipe
- Requires a water fitting to deliver water into the lavatory

d. Bathtub

- Rated at 2 DFU
- Requires a minimum of 1 1/2″ for drain pipe
- Requires a minimum of 1 1/2″ for vent pipe
- Requires a water fitting to deliver water into the tub
- Requires a trap and overflow connection to the waste pipe

e. Shower bath

- Rated at 2 DFU
- Requires a minimum of 2″ for drain pipe
- Requires a minimum of 1 1/2″ for vent pipe
- Requires a trap connection to the waste pipe
- Requires a water fitting to deliver water to the shower bath

f. Kitchen sink

- Rated at 2 DFU
- Requires a minimum of 1 1/2″ for drain pipe
- Requires a minimum of 1 1/2″ for vent pipe
- Requires a trap connection to the waste pipe
- Requires a water fitting to deliver water to the sink

g. Water heater

- Most common fuels are gas and electricity
- Usually constructed to heat and store water
- Usually constructed so the controls operate automatically

Information Sheet

h. Garbage disposal

- Rated at 2 DFU

  Note: This figure is usually not added to the unit load of the kitchen sink piping.

- Usually installed directly below kitchen sink in place of the basket strainer
- Requires a trap connection to the waste pipe
- Requires kitchen sink water supply to provide adequate flushing of the drain
- Requires electrical connection

i. Dishwasher

- Rated at 2 DFU
- Requires a minimum of 1 1/2" for drain pipe
- Requires a minimum of 1 1/4" for vent pipe
- Most dishwashers use a built-in pump to discharge waste water
- Most dishwashers have built-in automatic water controllers
- Requires a trap connection to the waste pipe or disposal

j. Laundry tray

- Rated at 2 DFU
- Requires a minimum of 1 1/2" for drain pipe
- Requires a minimum of 1 1/4" for vent pipe
- Requires a water fitting to deliver water to the laundry tray
- Requires a trap connection to the waste pipe

4. Construction and materials used in the manufacture of fixtures and appliances

a. Water closets

- Made by combining water, clay, and other materials into a semi-liquid state; materials are poured into molds to produce vitreous china

  Note: In the rough stage, the water closet is made in sections due to the difficulty of casting the trap and flushing compartments in one piece.

- Glazed and fired in a kiln at high heat for up to three days to ensure strength and quality of finish

Information Sheet

- Generally made in two sections, bowl and tank

  Note: Some models integrate the bowl and the tank into one casting.

- Tanks are equipped with separately installed flushing mechanisms.
- Water closet seats are manufactured in colors to match the water closet.

  Note: Water closet seats are constructed with closed fronts for residential use and open fronts for public use.

b. Bidets

- Made of vitreous china to afford clean washdown

  Note: Bidets are intended only for washing the body.

- Usually located next to the water closet
- Installed directly on the floor similar to a floor-mounted water closet

c. Lavatories

- Vitreous china
- Enameled cast iron
- Enameled pressed steel
- Stainless steel
- Plastic
- Fiberglass

d. Baths

- Materials
  - Enameled steel
  - Enameled cast iron
  - Fiberglass
- Construction
  - Bath bottoms should have 1/8" per foot pitch toward the drain.
  - Available in various sizes, shapes, and colors

    Note: Recessed tubs are the most common and are made in 4 1/2', 5', and 5 1/2' lengths.

  - Height of the flood rim varies between 13" and 16".

Information Sheet

e. Shower baths

- Materials
    - Terrazzo
    - Fiberglass
    - Cast stone
    - Enameled steel
- Walls
    - Fiberglass
    - Enameled steel
    - Glazed tile
    - Patented waterproof sheeting
- Construction
    - 30″ x 30″
    - 36″ x 36″
    - 36″ x 48″
    - Lead-pan sub-bases are made on the job from sheet lead and can be made in any floor size necessary.

f. Kitchen sinks

- Materials
    - Enameled cast iron
    - Enameled pressed steel
    - Stainless steel
- Available in various capacities
    - Single well (compartment)
    - Double well
    - Triple well

Information Sheet

g. Water heaters

- Most water heaters are steel tanks with bonded glass linings intended to prevent corrosion of the tank.

  Note: Solar heaters are rapidly becoming popular.

- Tank is insulated and covered with enameled steel jackets.

- Automatic controls are actuated by a thermostat.

  Note: Desired temperature can be predetermined by a manual control.

- Water heaters are constructed with three pipe openings in the top.

  — Cold water inlet

    Note: Also contains the dip tube that carries the cold water to the bottom of the tank.

  — Hot water outlet

    Note: Some water heaters incorporate magnesium anode rods into the hot water outlet to prevent electrolytic deterioration of the water heater.

  — Relief valve opening

    Note: Relief valves should be temperature-pressure actuated.

- If no opening is provided for a relief valve, most codes require that the valve be placed in the hot water line within 6" of the tank.

  Note: Refer to local codes.

- Water heaters are constructed with drain valves (boiler drains) at the bottom of the water tank.

- A drip line should extend from the relief/temperature valve to within 12" of the floor.

- Gas water heaters

  — Need gas piping connections

    Note: Some local codes allow flexible connectors at the heater.

  — Need an exhaust flue to the outside atmosphere

    Note: Flues should be as large as the exhaust outlet on the heater.

  — Water heaters and furnaces may use the same chimney if the heat flue enters the chimney above the furnace flue.

    Note: Check for combustion error.

Information Sheet

- Connecting directly to a furnace flue is permitted if a Y connection is used.
- Black iron pipe and fittings should be used for the gas piping.
- A shutoff valve (gas cock) should be installed in the gas line close to the heater.
- A union should be installed close to the heater for easy installation and removal of the heater.
- Manufacturer's instructions should be used for lighting and adjusting gas burners.

- Electric water heaters
  - Need no flue connection
  - Use an insulated heating element.
  - Some heaters have two heating elements, a lower element for normal use and an upper element when larger amounts of hot water are required.
  - Heaters are wired for 240 volts.

    Note: 120 volt heaters are available but are not as efficient as 240 volt heaters.
  - Electrical work should be done by a licensed electrician.

    Caution: Electrical connections should not be made until water heater has been filled with water.

h. Garbage disposals

- Four main components
  - Electric motor
  - Grinding chamber
  - Two grinding elements—rotating shredder and stationary grind ring
  - Sink fitting
- Operates on 120 volts
- Made of stainless steel, plastic, or other materials
- Easily installed in place of sink basket strainer and tail piece

  Note: Follow specific manufacturer's instructions for installation.
- Most disposals have a dishwasher drain connection.

Information Sheet

i. Dishwashers

- Self-contained units that need water and waste connections

  Note: Follow specific manufacturer's instructions for installation.

- Many types and models manufactured using various methods, designs, and materials

  Note: Plumbers should become acquainted with various models offered by manufacturers.

j. Laundry trays

- Most are made of fiberglass, cast iron, or plastic.
- Double-compartment and single-compartment models are available.
- Floor models with legs and wall-hung models are available.

Fixtures and Appliances
Unit 3-F

Job Sheet 1—Install a Floor-Mounted Water Closet

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Installed water closet in sturdy and level position	______
• Water closet did not leak when tested	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Water closet (complete bowl and tank)
- Water closet seat
- Wax seal
- Closet bolts (with bolt caps)
- Closet supply pipe (with angle valve)
  Note: Determine type of pipe connection before acquiring closet supply.
- Closet flange (with screws, if wood floor)
- 6′ steel rule or tape
- Pencil
- Cloth or rag
- Hacksaw (jab saw type preferred)
- Tubing cutters
- 8″ adjustable wrench
- Pipe joint compound
- Large straight screwdriver
- Socket wrench or water closet seat wrench
- Tools to install closet flange if not previously installed (soldering outfit, caulking tools, or plastic pipe tools)
- 2′ level
- Drop cloth

B. Procedure

☐ 1. Gather all equipment and materials and carry to the job site.

☐ 2. Install the water supply angle valve.

☐ 3. Install the water closet flange on the soil pipe if not previously done.

Job Sheet 1

☐ 4. Remove wax seal from wrapper or carton and place on water closet bowl outlet.

Note: Place firmly to avoid having the seal move when positioning the water closet bowl.

☐ 5. Position the closet bolts in the closet flange.

☐ 6. Carefully lift water closet bowl, turn right side up, and place over closet flange, centering bolt holes over bolts.

☐ 7. With a slight rocking motion, force the bowl down on the wax seal until the bowl sits evenly on the floor.

Note: In cold weather, the wax ring may have to be warmed before installation.

☐ 8. Check the bolt caps, and if any clips are necessary on the bolts, install them.

☐ 9. Place washers and nuts on bolt ends and hand tighten.

☐ 10. Place a level on the bowl parallel to the back wall and tighten bolts.

Note: Shims may be necessary to level the bowl.

☐ 11. Remove water closet tank from carton.

Note: Check for missing parts.

☐ 12. Place washers on tank bolts and insert down through bolt holes.

Note: Check parts list for correct and complete assembly.

☐ 13. Straddle the water closet bowl and carefully place tank on bowl, allowing the bolts to enter the bolt holes in the bowl.

☐ 14. Hold bolt heads (usually provided with screwdriver slot) with one hand and place washer and nut on end of each bolt.

Note: Sit on bowl facing tank.

☐ 15. Hold bolt heads in tank with large screwdriver, and tighten nuts under tank with adjustable wrench or socket wrench.

Note: Place level on top of tank and adjust bolts accordingly.

Job Sheet 1

☐ 16. Measure and cut the water supply tube.

Note: Allow for any bends needed.

- a. Hand tighten the supply tube to the ball cock shank.
- b. Make necessary bends.
- c. Determine length of supply tube and make scratch mark.
- d. Remove supply tube and cut to desired length.

☐ 17. Install the water supply tube using a small amount of pipe joint compound on threaded connections; this acts as a lubricant and creates a tighter joint.

Note: Hold ball cock with one hand while tightening shank connection.

☐ 18. If not previously done, secure angle valve in final position.

Note: This may be soldered, compression joint, or threaded.

☐ 19. Install seat, using socket wrench or W.C. seat wrench.

☐ 20. Check closet flange bolts for tightness.

☐ 21. Cut closet bolts off to desired height and install bolt caps.

☐ 22. Check tank bolts for tightness.

☐ 23. Turn on water and check for leaks.

- a. Packing gland on angle valve
- b. Under tank
- c. Supply tube
- d. Base of bowl

Note: If required, grout the base of the water closet bowl.

☐ 24. Set refill level in tank.

☐ 25. Ask your instructor to check your work.

☐ 26. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ____________________

Fixtures and Appliances
Unit 3-F

Job Sheet 2—Install a Wall-Mounted Lavatory

Name ______________________________ Attempt Number ____________

Date ______________________________ Overall Rating ____________

Evaluation Criteria	Rating
• Lavatory is level and sturdy	______
• Did not scar chrome fittings or faucets	______
• Joints did not leak when tested	______
• Water drains freely	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- 6′ rule
- Pencil
- 2′ level
- Hand drilling machine
- 3/8″ masonry drill
- 3/16″ twist drill
- Basin wrench
- 8″ adjustable wrench
- Tubing cutters: 1/2″, 1 1/2″
- Pipe joint compound
- Medium size screwdriver
- Spud wrench or all purpose wrench
- Plug wrench
- Six wood screws (for lavatory hanger)
- 1 1/2″ P trap (chrome plated brass tube, 17 gauge)
- Faucet (complete with drain plug)
- Set of flexible supply tubes with angle valves
- Lavatory (wall hung type)
- Grout

B. Procedure

☐ 1. Gather all equipment and materials and carry to the job site.

☐ 2. Make sure wall and floor of work area are clean.

☐ 3. Lay out tools in an orderly fashion and in easy reach.

Job Sheet 2

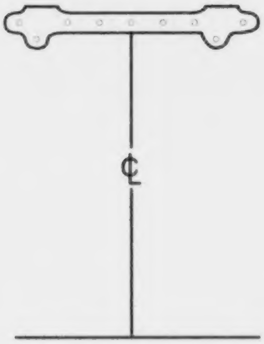
☐ 4. Take lavatory out of carton and make sure wall hanger is not missing.

Note: Use care in handling. Scratches could mean replacing the lavatory.

☐ 5. On bathroom wall, determine and lightly mark exact location (center line) of installation (Figure 1).

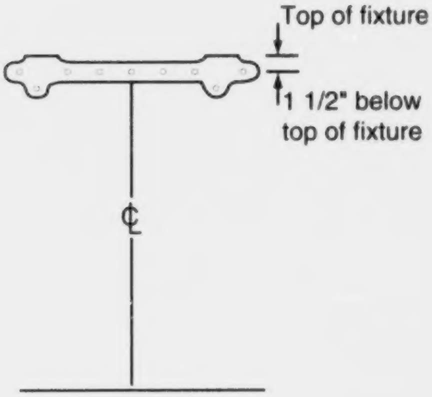
Note: Center line of lavatory is usually (but not always) directly above drain stub.

FIGURE 1



☐ 6. Determine hanger height from floor (Figure 2).

FIGURE 2

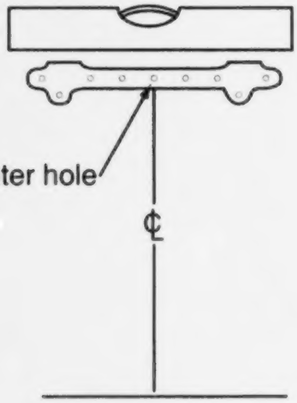


Job Sheet 2

☐ 7. Hold the hanger on the wall at the proper height and locate center screw hole on vertical center line (Figure 3).

Note: Level the hanger with the 2′ level.

FIGURE 3



☐ 8. Mark proposed screw locations on the wall.

☐ 9. Remove hanger.

Note: Accuracy in drilling holes is important.

☐ 10. Drill screw starter holes.

Note: Start holes in glazed tile by chipping the glaze off with a nail set. Tile and cement walls should be drilled with a masonry drill and wood backing should be drilled with a twist drill. If wood backing has not been installed, nylon anchors, molly bolts, or toggle bolts are acceptable in some cases. Usually legs are provided for the lavatory in such cases.

☐ 11. Install faucet and drain plug according to manufacturer's instructions.

Note: Refer to Unit 1-F, "Water Valves and Faucets."

☐ 12. Place lavatory on hanger, lightly tap downward with the heel of the hand, and check with 2′ level.

Note: Lavatory should seat firmly on the hanger.

☐ 13. Install water supply angle valve.

Note: Refer to Unit 1-F, "Water Valves and Faucets."

☐ 14. Connect supply tube to faucet shank (hand tight).

Job Sheet 2

☐ 15. Make necessary bends in supply tube and make scratch mark at desired length.

Note: Check for fitting allowance in the angle valve.

☐ 16. Remove supply tube and cut to desired length.

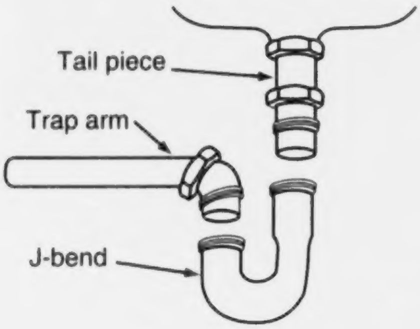
☐ 17. Place shank and angle valve nuts on supply tube and secure tube in position.

Note: A basin wrench is necessary to make a tight connection on the shank end.

☐ 18. Install trap (Figure 4).

Note: Refer to Unit 2-F, "Drainage Connections."

FIGURE 4



☐ 19. Ask your instructor to check your work.

☐ 20. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Fixtures and Appliances
Unit 3-F

Job Sheet 3—Install a Recessed Bathtub

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Bathtub is level and firm	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Bathtub (recessed, 5′)
- Tub waste and overflow
- Trap
- 1″ x 4″ x 4′ lumber cut into two–2′ sections
- Newspapers or other material to protect tub
- 6′ rule
- Pencil
- Long-handled broom
- Handsaw
- Hammer
- Nails (approximately one dozen, 10d or 16d)
- Vinyl shims

B. Procedure

☐ 1. Gather all equipment and materials and carry to the job site.

Note: Refer to manufacturer's specifications for installation requirements and note any changes in procedure.

☐ 2. Sweep out tub space.

Note: All trash should be removed and the floor made clean and smooth.

☐ 3. Uncrate the tub, being careful not to scratch it.

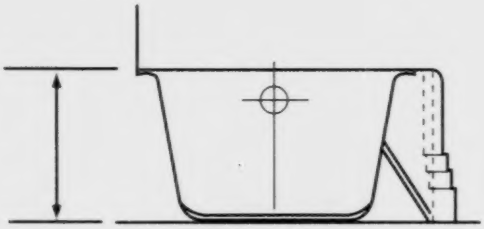
Note: You will need assistance with heavy tubs.

Job Sheet 3

☐ 4. Determine distance from floor to underside of tub's rear ledge (Figure 1).

Note: This measurement is usually not given on manufacturer's specifications.

FIGURE 1



Tub-end view

☐ 5. Pencil mark this distance on each stub of the back wall.

Note: Measure vertically from the floor.

☐ 6. If necessary, cut 1″ x 4″ lumber to fit tub opening.

☐ 7. Nail 1″ x 4″ lumber across studs, aligning upper edge with pencil mark.

Note: The top of the 1″ x 4″ ledge now represents the distance from floor to the underside of the tub.

☐ 8. Carefully bring the tub into the tub space and rest the rear ledge on the 1″ x 4″ support.

☐ 9. Level the tub (length and width), using vinyl shims if necessary.

Note: The tub should rest firmly on the ledge and the floor.

☐ 10. If the tub is made of enameled steel, secure it to the rear studs with shingle nails.

Note: Cast iron tubs need not be fastened down.

☐ 11. Completely cover the tub with protective materials.

Note: The bathroom may not be finished for weeks after the tub is installed and could be damaged if not protected.

☐ 12. Ask your instructor to check your work.

Job Sheet 3

☐ 13. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Fixtures and Appliances
Unit 3-F

Job Sheet 4—Install Shower Bath Accessories in a Ceramic Tile Bathroom

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	Rating
• Installed accessories correctly	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Strap wrench
- Pipe wrench
- Phillips head screwdriver
- Shower bath accessories
- Pipe compound
- Clean cloth

B. Procedure

☐ 1. Gather all equipment and materials and carry to the job site.

Note: Protect the tub from possible damage due to falling tools.

☐ 2. Remove test nipple and cap from shower pipe elbow using pipe wrench.

☐ 3. Connect shower head and arm and slide escutcheon over arm.

☐ 4. Apply pipe compound to threaded portion of shower arm and install arm in shower pipe elbow.

Note: Tighten only with strap wrench to avoid scratching chrome finish.

☐ 5. Move escutcheon to fit tightly to wall.

☐ 6. Remove protective coverings from bath-shower valves.

☐ 7. Install escutcheons and valve covers.

Note: Keep escutcheons tight to wall.

Job Sheet 4

☐ 8. Install valve handles, tightening screws with screwdriver.

☐ 9. Snap on screw-head covers.

☐ 10. Wipe valves and tub with clean cloth.

☐ 11. Ask your instructor to check your work.

☐ 12. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Fixtures and Appliances
Unit 3-F

Job Sheet 5—Install an Electric Water Heater

Name ______________________________ Attempt Number ____________

Date ______________________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Installed water heater correctly	______
• Pipe joints did not leak when tested	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Tubing cutter with reamer
- Air-acetylene torch
- Striker
- Tank wrench
- Solder
- Flux
- Sand cloth
- Adjustable wrench
- Tubing
- Fittings as needed
- Relief valve
- Water heater
- Two 3/4″ male adapters
- One 3/4″ gate valve

B. Procedure

☐ 1. Gather all equipment and materials and carry to the job site.

☐ 2. Remove water heater from carton.

☐ 3. Assemble soldering tools and solder two 3/4″ male adapters on two 8″ pieces of 3/4″ copper tubing.

☐ 4. Apply pipe compound to threaded portion of relief valve and install valve in heater.

Note: Location is usually marked.

☐ 5. Install tubing from relief valve to within 12″ of the floor.

Job Sheet 5

☐ 6. Position heater in proper place for installation.

Note: Electric elements must be accessible.

☐ 7. Apply pipe compound tape to 3/4″ male adapters and install in inlet and outlet openings using adjustable wrench.

Note: Check local codes for reference to dielectric unions.

☐ 8. Clean and flux 3/4″ valve and tubing ends protruding from 3/4″ male adapters.

☐ 9. Install 3/4″ valve on cold water inlet tubing.

☐ 10. Clean and flux tubing for cold and hot water connections.

☐ 11. Install tubing and make soldered connections.

Note: Open valve before soldering.

☐ 12. Close drain valve.

☐ 13. Open hot water faucet on nearest fixture.

☐ 14. Open cold water inlet valve on water heater.

Note: When water runs freely from fixture faucet, close inlet valve.

☐ 15. Check for leaks.

Note: When heater is first turned on, condensation may appear on the floor under the heater.

☐ 16. Ask your instructor to check your work.

Note: The job is now ready for the electrician.

☐ 17. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Fixtures and Appliances
Unit 3-F

Job Sheet 6—Install a Dishwasher

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Installed dishwasher correctly	______
• Connections did not leak when tested	______
• Drain line did not allow backfill	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Air-acetylene torch
- Striker
- Gas tank
- Tank wrench
- Solder
- Flux
- Sand cloth
- Adjustable wrench
- Flaring tool and block
- Flare nut wrench
- Level
- Screwdriver
- 1/2″ tubing cutter
- Tubing
- Fittings and valves
- Dishwasher adapter sink tail piece
- 6′ rule or steel tape
- Clean cloth

B. Procedure

Note: Check manufacturer's specifications before proceeding.

☐ 1. Gather all equipment and materials and carry to the job site.

☐ 2. Place dishwasher in position in the cabinet.

☐ 3. Locate water inlet and outlet on dishwasher.

Job Sheet 6

☐ 4. Using adjustable wrench, install union on inlet and outlet connections.

Note: Dishwashers must be able to be disconnected in order to be removed easily.

☐ 5. Shut off hot water supply to kitchen sink and drain the line.

☐ 6. Cut into hot water line under sink and install tee and valve to dishwasher.

☐ 7. Run line from valve to water inlet on dishwasher and solder all connections.

Note: Check manufacturer's specifications.

☐ 8. Remove tail piece from sink drain nearest dishwasher and replace with dishwasher adapter tail piece using spud wrench.

☐ 9. Measure and cut copper tubing to fit from drain union to dishwasher to adapter tail piece on sink drain.

Note: Check manufacturer's specifications for drain loop to prevent sink backup into dishwasher.

☐ 10. Clean and flux all connections.

☐ 11. Install tubing and solder connections.

☐ 12. Turn on water and check for leaks.

Note: Electrician must connect electricity in order to check all connections.

☐ 13. Check manufacturer's instructions for securing dishwashers to cabinet and leveling legs.

☐ 14. Replace front cover.

☐ 15. Ask your instructor to check your work.

☐ 16. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ____________________

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Fixtures and Appliances
Unit 3-F

Job Sheet 7—Install a Garbage Disposal Unit

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Installed garbage disposal correctly	______
• Joints did not leak when tested	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Adjustable spud wrench or all-purpose wrench
- Pipe compound
- Strainer wrench
- 2″ tubing cutter
- Garbage disposal unit
- Directional tee

B. Procedure

Note: Check manufacturer's specifications before proceeding.

☐ 1. Gather all equipment and materials and carry to the job site.

☐ 2. Remove garbage disposal unit from carton and read manufacturer's instructions.

☐ 3. Remove sink tailpiece using adjustable spud wrench.

☐ 4. Loosen basket strainer in sink using strainer wrench.

☐ 5. Position disposal unit under sink drain.

☐ 6. Screw basket strainer into top of disposal unit and tighten locknut using strainer wrench.

☐ 7. Install continuous waste drain into disposal unit and tighten slip joints with adjustable spud wrench.

Note: Use a directional (venturi) tee in the continuous waste drain.

Job Sheet 7

☐ 8. Install trap between disposal unit and waste drain and tighten slip joints with adjustable spud wrench.

☐ 9. Turn on the water into sink and check for leaks.

☐ 10. Ask your instructor to check your work.

Note: An electrician should make electrical connection.

☐ 11. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Fixtures and Appliances
Unit 3-F

Job Sheet 8—Install a Gas Water Heater

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Installed water heater correctly	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Instructions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Gas water heater
- Relief valve
- Pipe
- Fittings and valves
- Vent pipe
- Pipe vise
- Pipe cutter
- Reamer
- Pipe threader
- Oil can
- Black iron pipe
- Gas pipe fittings and valves
- Drop cloth
- Soap and water solution

B. Procedure

Note: Check manufacturer's specifications before proceeding.

☐ 1. Gather all equipment and materials and carry to the job site.

☐ 2. Locate relief valve outlet on water heater.

☐ 3. Install relief valve.

☐ 4. Attach 3/4" approved line from relief valve to location of desired overflow.

Note: End of line must not be threaded.

Job Sheet 8

☐ 5. Using nipple, elbow, and union, install 3/4″ galvanized line from heater to cold water supply line.

☐ 6. Using nipple, elbow, and union, install 3/4″ galvanized line from heater to hot water supply line.

☐ 7. Using 3″ galvanized vent pipe, run vent into chimney.

☐ 8. Using black iron pipe and fittings required, connect gas line to heater.

☐ 9. Turn gas supply on and check for leaks using soap and water solution as a leak detector.

☐ 10. Open hot water faucet in kitchen sink.

☐ 11. Turn on water supply.

☐ 12. Fill hot water tank until water flows from hot water faucet in kitchen sink.

☐ 13. Light and adjust burner.

☐ 14. Ask your instructor to check your work.

☐ 15. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Water Systems Maintenance and Repair
Unit 1-G

Objective Sheet

Unit Objective

After completing this unit, the student should be able to install a prefabricated air chamber in a water supply line; thaw a frozen pipe; replace a section of galvanized water supply line, a gas water heater, and a pressure control switch on a water pump; and repair various sections of the plumbing system. The student should demonstrate these competencies by completing the job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

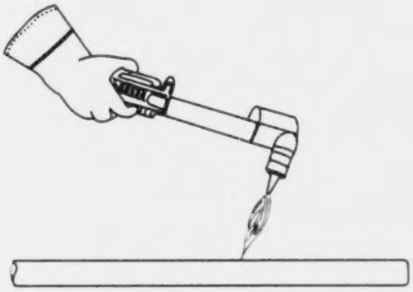
1. Match terms related to water systems maintenance and repair with their definitions.
2. Describe methods of thawing frozen pipes.
3. Describe emergency repair methods for leaking pipes.
4. Match water closet tank malfunctions with their remedies.
5. Install a prefabricated air chamber in a water supply line. (Job Sheet 1)
6. Replace a section of galvanized water supply line. (Job Sheet 2)
7. Thaw a frozen pipe with a plumber's torch. (Job Sheet 3)
8. Repair a leaking faucet. (Job Sheet 4)
9. Repair a leaking shower valve. (Job Sheet 5)
10. Replace a gas water heater. (Job Sheet 6)
11. Repair a ball cock on a water closet. (Job Sheet 7)
12. Replace a pressure control switch on a water pump. (Job Sheet 8)
13. Insulate water lines. (Job Sheet 9)

Water Systems Maintenance and Repair
Unit 1-G

Information Sheet

1. **Terms and definitions**
    a. **Frozen pipe**—Water frozen in a pipe, causing stoppage and danger of pipe damage
    b. **Maintenance**—Keeping equipment and plumbing systems functioning in an approved manner
    c. **Malfunction**—Failure to operate in a normal or usual manner
    d. **Open flame**—Flame not confined to a protected area and therefore dangerous
    e. **Repair**—To remedy or restore something that is broken or not in proper working order

2. **Methods of thawing frozen pipes**
    a. Open flame (low temperature flame)



Note: Do not use an open flame to thaw pipes inside a building.

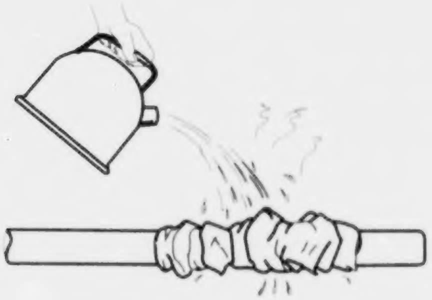
- Open faucet or valve affected by the freeze.
- Apply heat at the lowest open end of the frozen section.

  Note: Do not start in the middle of a frozen section, as a pocket of steam could develop and an explosion or damage to the pipe could occur.

- Slowly move the flame along the length of the frozen section of pipe; continue until water flows freely from pipe.

Information Sheet

b. Hot water



Note: This method is recommended for use inside buildings.

- Open faucet or valve affected by the freeze.
- Wrap the frozen section of pipe with clean cloths.

  Note: Avoid oily cloths or other nonabsorbent cloths.

- Pour hot water over the entire length of the frozen area, starting from the open end of the pipe, and continue until water flows freely from the pipe.

c. Electric welding generator

Note: This is most commonly used to thaw service pipes and other underground lines.

- Determine the location of the frozen section of pipe.
- Select contact points as close as possible to the frozen area.
- Be sure that contact points are free of rust, grease, or scale.
- Remove meters, electrical ground connections, and couplings attached to plumbing in line to be thawed.

  Note: If there are gaskets or other insulators at pipe joints, thaw pipe in sections between such joints or use copper jumpers.

Information Sheet

- Set the direct-current generator to correct amperage for pipe to be thawed (Table 1).

Table 1. Current and Voltage Required for Thawing Pipes

Type of pipe	Pipe size (in.)	Pipe length (ft.)	Approximate volts	Approximate volts[1]
Wrought iron	3/4	600	60	250
	1	600	60	300
	1 1/2	600	60	350
	2	500	55	400
	3	400	40	450
Cast iron	4	400	50	500
	6	400	50	600
	8	300	40	600

[1] Use no more than 100 amperes on lead pipes that have lead fittings or any soldered joints.

- Connect pipe.

  Note: On alternating-current circuits, a transformer must be used to adjust the amperage to the pipe being thawed.

- Apply current until water flows freely.

d. Electric pipe thawer

Note: This is a portable unit that is used inside buildings.

- Determine the location of the frozen section of the pipe.
- Attach the pipe clamps at both ends of the frozen pipe section.
- Plug unit into 110–120 volt house receptacle.
- Turn on switch and adjust amperage flow to safe range as indicated.
- Apply current until water flows freely.

e. Flowing hot water

Note: This method is used for thawing underground or other inaccessible pipe.

- Remove fittings from pipe to be thawed.
- Insert small pipe or tube into open end of frozen pipe.
- Add an elbow and piece of vertical pipe to the outer end of the thaw pipe.
- Place a bucket under the opening of the frozen pipe.
- Insert a funnel in the open end of the vertical pipe.
- Pour boiling water through the funnel and into the thaw pipe.

Information Sheet

- As the ice melts, push the thaw pipe farther into the frozen pipe.
- Withdraw the thaw pipe quickly when the water starts to flow.

  Note: Do not stop the flow until the thaw pipe is fully removed and cleared of ice.

f. Hair dryer

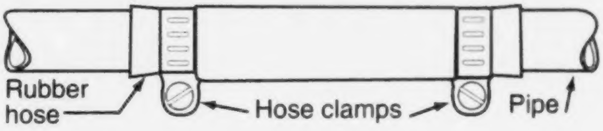
Note: A pistol type hair dryer works best.

- Open faucet or valve affected by the freeze.
- Connect dryer to electrical power.
- Apply heat over entire length of frozen area, starting from the open end of the pipe, and continue until water flows freely.

3. Emergency repair methods for leaking pipes

Note: Emergency repairs are strictly temporary.

a. Rubber hose method

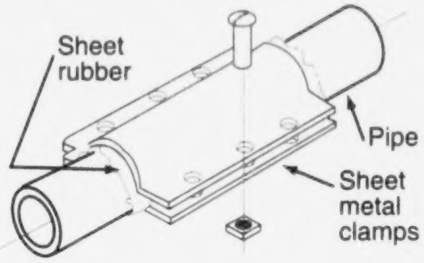


- Turn off the water supply.
- Cut the defective section of pipe at the leak.
- Slip a small section of hose over one end of cut pipeline and line up pipes evenly.

  Note: Inside diameter of hose must be nearly the same as outside diameter of defective pipe.

- Slide hose halfway over the other end of cut pipeline.
- Fasten hose tightly with hose clamps.

b. Sheet metal clamps method



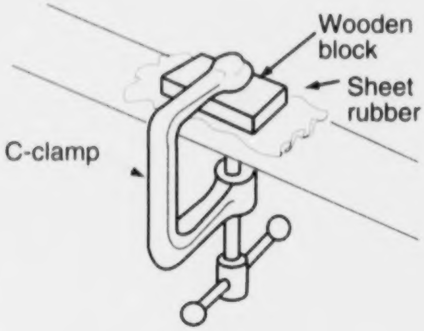
- Turn off the water supply.
- Wrap the leaky area with sheet rubber.

Information Sheet

- Place sheet metal clamps, one on either side of the pipe, on the sheet rubber covering.
- Fasten the clamps with bolts and nuts.

Note: Clamps can be purchased from plumbing supply houses, or they can be made from scrap sheet metal.

c. C-clamp method

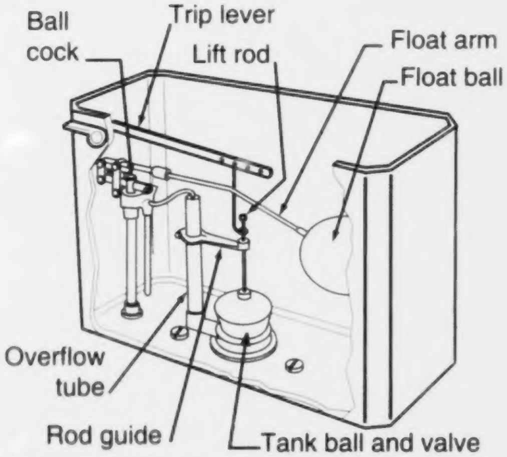


- Turn off the water supply.
- Cut a small piece of sheet rubber and place on the defective part of the pipe.
- Place a small wooden block on the rubber sheet.
- Place C-clamp in position and tighten against wooden block to hold sheet rubber on pipe.

Note: A hose clamp can also be used in some cases.

4. Water closet tank malfunctions and their remedies

a. Float rises too high in tank, allowing water to continue flowing and to drain into the overflow tube.



Information provided by Mansfield Plumbing Products, Inc....America's Best Value!

Information Sheet

- Bend float arm to make sure float is clear of tank sides and is not held in a high position.
- Make sure float does not rise above desired water level by bending the float arm until desired level is reached.

  Note: Use both hands to bend float arm, as excessive strain on the float arm connection can damage the ball cock.

b. Water continues to flow, draining through tank ball valve due to worn or deformed tank ball.

- Clean existing ball and wipe valve seat clean.
- If valve continues to leak, replace tank ball.

c. Tank ball assembly fails to reseat ball valve due to misalignment.

- Make sure lift rods are straight and aligned over ball valve.
- Make sure trip lever is aligned over the ball valve.
- Make sure rod guide is aligned over the ball valve.

d. Leaking ball cock valve allows water to continue flowing after float rises to normal shut-off position.

- Check linkage of float arm lever and valve plunger for defects which prevent valve closing.

  Note: Some water corrodes brass parts.
- Replace valve washer.

e. Water continues to flow, draining into base of overflow tube due to corrosion of threaded end of overflow tube.

- Remove overflow tube and clean broken threads from tube base.
- Install new overflow tube.

  Note: Measure and cut to correct length before installing.

f. Water continues to flow as float is water-logged and does not rise.

- Remove float and make repairs.
- Remove float and replace with new float.

Water Systems Maintenance and Repair
Unit 1-G

Job Sheet 1—Install a Prefabricated Air Chamber in a Water Supply Line

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Air chamber suppressed all noise caused by water hammer	______
• Joints did not leak when tested	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Air chamber
- Tubing cutters with reamer
- Tee
- Soldering tools
  - — Torch and tank
  - — Striker
  - — Flux
  - — Sand cloth
  - — Fitting brush
  - — Solder
  - — Clean cloth

Note: To stop small amounts of water from moving through a joint to be soldered, stuff bread into the pipe until water stops. After soldering the joint, the water can be turned on and the bread will wash out of the pipe.

B. Procedure

☐ 1. Determine location of noise.

☐ 2. Obtain access to water supply line.

☐ 3. Determine size of air chamber required for line.

☐ 4. Shut off water supply.

☐ 5. With tubing cutters, cut line at point where chamber will be installed.

Note: An air chamber may be installed in either the horizontal or vertical position.

Job Sheet 1

☐ 6. Drain water from the line.

☐ 7. After removing burrs by reaming, clean tubing ends with sand cloth.

☐ 8. Clean solder cups on air chamber and tee.

☐ 9. Apply flux to all parts to be soldered.

☐ 10. Place the air chamber in position in the line and support it to assure that it is level and plumb.

☐ 11. Light the torch and solder the connections.

Note: Wipe excess solder and flux from joint, using a clean cloth.

☐ 12. When joints are cooled, turn on water and test for water hammer.

☐ 13. Ask your instructor to check your work.

☐ 14. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ____________________

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Water Systems Maintenance and Repair
Unit 1-G

Job Sheet 2—Replace a Section of Galvanized Water Supply Line

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Joints did not leak when tested	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Four-wheel pipe cutter
- Pipe wrenches
- Steel pipe nipple
- Steel union
- Pipe vise
- Pipe threader
- Pipe reamer
- One-wheel pipe cutter
- Pipe compound or tape
- Flat file

Note: If outside burr from four-wheel cutter operation is excessive, remove the burr with a flat file.

B. Procedure

☐ 1. Turn off water supply.

☐ 2. Measure length of pipe to determine length of replacement.

☐ 3. Cut pipe at desired place using a four-wheel cutter.

☐ 4. Disconnect pipe and fitting, and hangers if necessary.

☐ 5. Assemble nipple and half union, and connect to fittings in supply line.

☐ 6. Measure, cut, and thread replacement pipe, allowing for fittings.

☐ 7. Connect unions.

Job Sheet 2

☐ 8. Turn on water supply.

☐ 9. Check for leaks.

☐ 10. Ask your instructor to check your work.

☐ 11. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Water Systems Maintenance and Repair
Unit 1-G

Job Sheet 3—Thaw a Frozen Pipe With a Plumber's Torch

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Water flowed freely through pipe after thawing	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Torch and tank
- Pipe (for simulated frozen condition)
- Fire extinguisher
  Note: A fire extinguisher should be kept on hand in a convenient location any time a torch is used.
- Fireproof material

B. Procedure

☐ 1. Locate frozen area of pipe.

☐ 2. Open faucet or valve.

☐ 3. Light torch and adjust flame.

☐ 4. Apply heat in a back and forth motion over entire length of freeze.

Caution: Take precautions against fire by using fireproof material.

☐ 5. Continue until water runs freely through lines.

☐ 6. Remove torch and extinguish flame.

☐ 7. Allow water to flow for several minutes to avoid refreezing.

☐ 8. Close faucet or valve.

☐ 9. Ask your instructor to check your work.

Job Sheet 3

☐ 10. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ____________________

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Water Systems Maintenance and Repair
Unit 1-G

Job Sheet 4—Repair a Leaking Faucet

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Did not scar or damage faucet	______
• Faucet did not leak after repair	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Strap wrench
- Screwdriver
- Compression type faucet
- Adjustable wrench
- Knife
- Washers
- Seat-dressing tool
- Packing ring
- Handle puller
- Stem grease

B. Procedure

☐ 1. Shut off water supply to faucet.

☐ 2. Turn faucet handle to open faucet and remove handle.

☐ 3. Remove packing nut using adjustable wrench.

☐ 4. Remove spindle to expose washer.

☐ 5. Check seat for wear.

☐ 6. Inspect stem for wear.

☐ 7. Remove brass washer screw with screwdriver.

☐ 8. Lift washer with knife tip.

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☐ 9. Replace washer with new one and tighten with screwdriver.

Job Sheet 4

☐ 10. Replace packing ring between cap nut and spindle as follows:

  a. Remove cap nut and spindle.

  b. Remove handle from top of stem using a handle puller wrench.

  c. Replace packing ring.

☐ 11. Dress faucet ground seat as follows:

  a. Insert seat-dressing tool in faucet and press threaded cone down into body opening.

  b. Center spindle and cutter in faucet.

  c. Using moderate downward pressure, rotate handwheel to the right to dress seat.

  Note: Seat should be clean and free from burrs and nicks when dressed.

☐ 12. Reassemble remaining parts.

Note: Apply stem grease to stem.

☐ 13. Ask your instructor to check your work.

☐ 14. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ____

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Water Systems Maintenance and Repair
Unit 1-G

Job Sheet 5—Repair a Leaking Shower Valve

Name ______________________________ Attempt Number ____________

Date ______________________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Shower valve did not leak after repair	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Adjustable wrench
- Screwdrivers
- Plumber's socket wrench set
- Valve seat wrench
- Valve seat (new)
- Washer (new)
- Pipe compound
- Clean cloth
- Knife
- Handle puller
- Stem grease

B. Procedure

☐ 1. Cut off water supply to valve.

☐ 2. Remove valve handle with handle puller.

☐ 3. Remove escutcheon.

☐ 4. Loosen valve bonnet with socket wrench and remove valve stem assembly.

☐ 5. Remove and replace valve seat using valve seat wrench.

☐ 6. Remove washer on end of stem using knife tip.

☐ 7. Replace washer using screwdriver.

☐ 8. Reassemble valve, using pipe compound to lubricate threads.

Job Sheet 5

☐ 9. Tighten packing nut using adjustable wrench.

Note: Apply stem grease to stem.

☐ 10. Replace escutcheon and valve handle.

☐ 11. Wipe valve and adjacent area with clean cloth.

☐ 12. Ask your instructor to check your work.

Note: The job is now ready for the electrician.

☐ 13. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Water Systems Maintenance and Repair
Unit 1-G

Job Sheet 6—Replace a Gas Water Heater

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Positioned vent pipe properly	______
• Roof flashing prevents water leaks	______
• Hot water heater burner flame is properly adjusted	______
• Hot and cold water supply lines do not leak	______
• Hot water heater is installed in a stable position	______
• Relief valve outlet is properly installed	______
• Heater is positioned to be accessible for maintenance	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Tubing cutter
- Garden hose
- Soldering tools
  - — Torch and tank
  - — Solder
  - — Flux with brush
  - — Striker
  - — Sand cloth and fitting brush
  - — Clean cloth
- Temperature and pressure relief valve
- Fittings
- Pipe wrenches
- Tin snips
- Pipe compound or tape
- Screwdriver
- Cloths to wipe up spilled water

B. Procedure

☐ 1. Close gas valve to heater.

☐ 2. Close water supply valve to water heater.

☐ 3. Connect garden hose from heater drain valve to nearest drain or place outdoors.

Note: Do not run water on lawn or flower beds.

Job Sheet 6

☐ 4. Open heater drain valve and drain as much water from the heater as possible.

Note: The highest hot water faucet in house must be open in order to allow water to leave the heater and drain the water line.

☐ 5. Set up tools and equipment and bring in the new water heater while water drains from the old one.

☐ 6. Disconnect the relief valve overflow line.

☐ 7. Disconnect gas supply at union near heater.

☐ 8. Remove gas connection on heater.

☐ 9. Remove flue pipe.

☐ 10. Close drain valve and remove garden hose when tank is empty.

☐ 11. Cut hot and cold lines directly above heater with tubing cutters.

☐ 12. Remove old water heater and replace with new water heater.

Note: New heater should have been ordered to correspond to the height of the old heater.

☐ 13. Line up gas and water supplies with the new heater connections.

☐ 14. Remove adapters from old heater and reuse if not damaged.

Note: Install new relief valve.

☐ 15. Connect water supplies to heater using couplings or new pipe.

☐ 16. Connect gas supply to heater.

☐ 17. Connect the flue pipe from heater to chimney.

☐ 18. Make sure drain valve is closed and turn on water supply.

Note: Reseal at chimney to prevent flue gas leaks and improper combustion according to local codes.

☐ 19. Check for water leaks.

☐ 20. Open gas valve to heater.

☐ 21. Check for gas leaks using soap and water.

☐ 22. Light gas pilot and burner.

Job Sheet 6

☐ 23. Adjust flame if necessary.

☐ 24. Ask your instructor to check your work.

☐ 25. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ____

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Water Systems Maintenance and Repair
Unit 1-G

Job Sheet 7—Repair a Ball Cock on a Water Closet

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Ball cock provides rapid, automatic water delivery	______
• Fixture does not overflow	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Water closet (tank type)
- Screwdrivers
- Adjustable wrench
- Spud wrench or all-purpose wrench
- Vise-grip pliers
- New ball cock
- Pipe compound
- Clean cloth
- Sponge

B. Procedure

☐ 1. Shut off water to fixture stop valve.

☐ 2. Remove top from tank.

☐ 3. Completely drain the tank and sponge out the water that does not drain.

☐ 4. From underside of closet tank, remove the nut that holds ball cock and lift flush valve from tank.

☐ 5. Remove diaphragm and rubber seat from guide.

☐ 6. If worn, replace diaphragm, plunger, and seat washer.

☐ 7. If worn, replace diaphragm guide.

☐ 8. Replace ball cock if above steps are inappropriate.

Job Sheet 7

☐ 9. Replace tank top.

☐ 10. Turn water on.

☐ 11. Check operation of ball cock.

☐ 12. Ask your instructor to check your work.

☐ 13. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Water Systems Maintenance and Repair
Unit 1-G

Job Sheet 8—Replace a Pressure Control Switch on a Water Pump

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Switch provided designated water pressure	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Water pump with pressure control
- New pressure control
- Screwdriver
- Set of open-end wrenches
- Pipe compound or tape

B. Procedure

☐ 1. Turn off power supply.

☐ 2. Remove cover from pressure switch.

☐ 3. Disconnect wiring on switch, observing carefully the correct location of wire leads on the switch.

☐ 4. Remove switch on pump, using open-end wrench.

☐ 5. Install new switch on pump, using open-end wrench.

Note: Apply pipe compound or tape to male threads.

☐ 6. Connect wire leads on switch, using a screwdriver.

☐ 7. Turn on power supply.

☐ 8. Check operation of pump.

Note: Switch may have to be adjusted to produce the desired pressure and differential.

Job Sheet 8

☐ 9. Ask your instructor to check your work.

☐ 10. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Water Systems Maintenance and Repair
Unit 1-G

Job Sheet 9—Insulate Water Lines

Name ______________________ Attempt Number ____________

Date ______________________ Overall Rating ____________

Evaluation Criteria	**Rating**
• Covered all exposed pipe surfaces with insulation	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Insulation
- Pipe and fittings
- Insulation cement
- Pocket knife
- Duct tape

B. Procedure

☐ 1. Spread split insulation.

☐ 2. Fit over straight length of pipe.

☐ 3. Butt each 3′ length end to end.

☐ 4. Apply cement to canvas overlap tab.

☐ 5. Press both edges of insulation together.

☐ 6. Press canvas to tab down.

☐ 7. Cut V-notch in center of elbow to fit around elbow.

☐ 8. Fold insulation over elbow.

☐ 9. Mold together.

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☐ 10. Notch out at center of tee outlet to fit around tee.

Job Sheet 9

☐ 11. Split insulation.

☐ 12. Fit around tee.

☐ 13. Cut V-shaped piece of insulation to size needed.

☐ 14. Slide into notch at center of tee.

☐ 15. Apply duct tape if needed.

☐ 16. Ask your instructor to check your work.

☐ 17. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ____

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Drainage Systems Maintenance and Repair
Unit 2-G

Objective Sheet

Unit Objective

After completing this unit, the student should be able to replace a lavatory trap and remove obstructions from drain lines. The student should demonstrate these competencies by completing the job sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to drainage systems maintenance and repair with their definitions.
2. List types of equipment used to clear stoppages in plumbing fixtures.
3. List cleanout access points in a drainage system.
4. Replace a lavatory trap. (Job Sheet 1)
5. Clear obstructions from a lavatory drain. (Job Sheet 2)
6. Clear obstructions from a water closet drain. (Job Sheet 3)
7. Clear obstructions from a main drain line. (Job Sheet 4)

Drainage Systems Maintenance and Repair
Unit 2-G

Information Sheet

1. **Terms and definitions**

    a. **Auger**—Rotary tool used by plumbers to clear drains

    b. **Caustic chemicals**—Chemicals in either liquid or powder form used to dissolve soap, grease, and other accumulations in drain pipe

    c. **Plumber's friend**—Plunger used to help clear fixture drains, saving the plumber from messy work

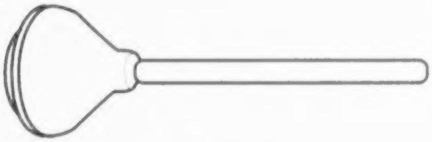
    d. **Snake**—Steel band or spring, coiled for easy use, used to clear plumbing drains

2. **Equipment used to clear stoppages in plumbing fixtures**

    Note: Check for acid or any other corrosive substance before working on drains.

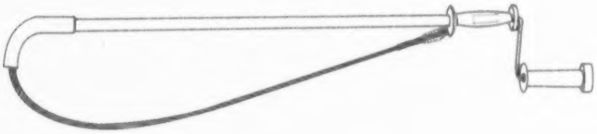
    a. **Plunger**

    Note: A plunger is also known as the "plumber's friend" or "force cup."



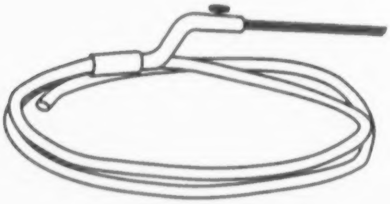
    b. **Closet auger**

    Note: After using, wash with clean water and oil to avoid rusting.



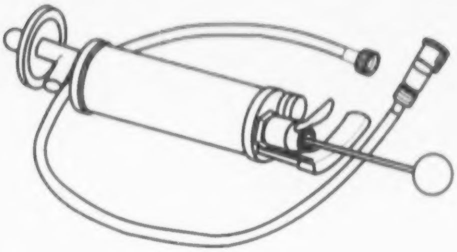
    c. **Trap and drain auger**

    Note: The trap and drain auger is best used on waste pipes and traps that are not easily disassembled.



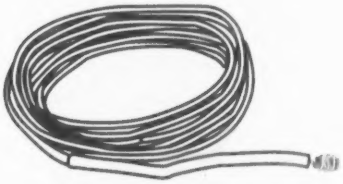
d. **Water ram**

Note: Use the water ram with care since it can blow water out of other fixture traps.



e. **Plumber's snake**

Note: Plumber's snakes are either electric or manual. Small snakes may help to loosen stoppages in lavatory and kitchen sink traps, but the best solution is to remove and clean the trap.



f. **Caustic chemicals**

Caution: Use caustic chemicals only as a last resort, especially to remove grease and soap build-up in drain lines. Do not use in plastic pipes.

3. **Cleanout access points in a drainage system**

Note: Check local codes.

a. Base of stack

Note: Many codes require a cleanout at the base of each vertical drain pipe.

b. Vent terminals

Note: These are specifically intended for clearing blocked stacks.

c. Cleanouts in sewer line

Note: Check local codes. Many codes require buried sewer lines to have a cleanout for every 50′ of pipe.

d. Traps

Note: Lavatory, kitchen sink, and exposed bath and shower traps should be made to be easily removed.

e. Water closets

Note: Remove water closet for drain cleaning only after making all other attempts.

Drainage Systems Maintenance and Repair
Unit 2-G

Job Sheet 1—Replace a Lavatory Trap

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Replaced trap in 15 minutes or less	______
• Trap did not leak when tested	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the above criteria.

A. Equipment and materials

- Lavatory with P trap
- Adjustable wrench or all-purpose wrench
- Pan to catch trap water
- New trap with washers and slip nuts
- Pipe compound
- Drop cloth

B. Procedure

☐ 1. Spread drop cloth under lavatory.

☐ 2. Disconnect slip-joint nuts at lavatory trap.

Note: Use pan to catch trap water.

☐ 3. Replace lavatory trap, using complete kit provided by manufacturer and other necessary materials.

☐ 4. Check for leaks.

☐ 5. Ask your instructor to check your work.

☐ 6. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Drainage Systems Maintenance and Repair
Unit 2-G

Job Sheet 2—Clear Obstructions From a Lavatory Drain

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Obstructions were cleared and water flowed freely through the drain	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Lavatory with P trap
- Adjustable wrench
- All-purpose wrench
- Cloth
- Plunger
- Flexible cable with auger
- Caustic chemical
- Clean rag
- Pipe compound

B. Procedure

☐ 1. Remove cleanout or drain stopper and check for obstruction.

☐ 2. Remove any obstruction and check for proper drainage.

☐ 3. If problem is not solved, plug overflow opening with rag and force air and water through drain line with a vacuum plunger.

☐ 4. If problem is not solved, rod out drain line with flexible cable and auger.

☐ 5. If limited amount of water is moving, pour caustic chemical into drain, following chemical manufacturer's instructions.

☐ 6. If problem persists, disassemble, clean, and reassemble drain and P trap.

☐ 7. Ask your instructor to check your work.

Job Sheet 2

☐ 8. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________________

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Drainage Systems Maintenance and Repair
Unit 2-G

Job Sheet 3—Clear Obstructions From a Water Closet Drain

Name ______________________________ Attempt Number ______________

Date ______________________________ Overall Rating ______________

Evaluation Criteria	**Rating**
• Obstructions were cleared and water flowed freely through the drain	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Water closet connected to drain system
- Plunger
- Closet auger
- Bucket

B. Procedure

☐ 1. Remove cover from tank.

☐ 2. Force water through the water closet drain using a vacuum plunger.

☐ 3. Flush water closet.

Note: Be prepared to stop water flow if necessary.

☐ 4. If problem still exists, rod out drain with flexible cable and auger.

☐ 5. Remove auger from drain, pulling obstruction with auger.

☐ 6. If obstruction cannot be dislodged with auger, disconnect water closet, and remove obstruction from drain.

☐ 7. Flush with handful of toilet tissue to test flushing action.

☐ 8 Ask your instructor to check your work.

Job Sheet 3

☐ 9. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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Drainage Systems Maintenance and Repair
Unit 2-G

Job Sheet 4—Clear Obstructions From a Main Drain Line

Name ______________________ Attempt Number __________

Date ______________________ Overall Rating __________

Evaluation Criteria	**Rating**
• Obstructions were removed	______
• Drain line functioned with normal amount of waste	______
• Followed proper safety precautions	______
• Used tools and equipment correctly	______
• Demonstrated quality of workmanship	______
• Completed task in a timely manner	______

Directions: When you are ready to perform this task, ask your instructor to observe the procedure and rate your performance using the evaluation criteria.

A. Equipment and materials

- Power sewer auger with attachments
- Caustic chemical
- Spud wrench or cleanout wrench
- Heavy gloves (approved type)
- Clean cloths

B. Procedure

☐ 1. Locate cleanout opening in drain line; if none exists, remove appropriate fixture.

☐ 2. Attach proper size bit on end of cable.

☐ 3. Insert bit and cable into fixture drain line.

☐ 4. Bend cable as required to reach obstruction.

☐ 5. Activate power auger and clean line, removing and cleaning auger as necessary.

☐ 6. Run water through line.

☐ 7. Repeat process until line is cleaned.

☐ 8. Replace fixture.

☐ 9. Ask your instructor to check your work.

Job Sheet 4

☐ 10. Clean tools and work area and return all equipment and materials to their proper places.

Evaluator's Comments: ______________________________

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